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Remedial Investigation Report

for

Operable Unit 3
Naval Air Warfare Center

Warminster, Pennsylvania

Northern Division
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298
Contract Task Order 0159

August 1994

Halliburton NUS
CORPORATION

Halliburton NUS
CORPORATION

661 ANDERSEN DRIVE • PITTSBURGH, PENNSYLVANIA 15220-2745 (412) 921-7090

76

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Halliburton NUS Project Number 1412

August 5, 1994

Mr. Lonnie Monaco
Northern Division , Code 0223
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop #82
Lester, Pennsylvania 19113

Reference: **Contract No. N62472-90-D-1298 (CLEAN)**
Contract Task Order (CTO) 0159

Subject: **FINAL REMEDIAL INVESTIGATION REPORT - OPERABLE UNIT 3**

Dear Mr. Monaco:

Enclosed are two (2) copies of the subject document for the CERCLA RI work at NAWC Warminster. Copies of this report are being sent to individuals identified on the distribution list.

Please contact me at (412) 921-8778, if you have any questions or comments.

Sincerely,

Jeffrey P. Orient

Jeffrey P. Orient
Project Manager

JPO/sic

Attachment

cc: Ray Manella (Navy, NORTHDIV)
Tom Ames (NAWC, Warminster)
Dave Kennedy (PADER)
Darius Ostrauskas (EPA, Region III, 3 copies)
Kathy Davies (EPA, Region III)
Ron Sloto (U.S.G.S.)
Kevin Kilmartin (Halliburton NUS, Wayne)
Neil Teamerson (Halliburton NUS, Wayne)
Michael Turco (Halliburton NUS, Wayne)
Dave Fennimore (Earth Data)
Tony Bartolomeo (Pennoni Associates, Inc.)

R-06-94-2

REMEDIAL INVESTIGATION REPORT

OPERABLE UNIT 3
NAVAL AIR WARFARE CENTER (NAWC)
WARMINSTER, PENNSYLVANIA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Northern Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop #82
Lester, Pennsylvania 19113-2090

Submitted by:
Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0159

AUGUST 1994

SUBMITTED BY:

JEFFREY P. ORIENT
PROJECT MANAGER
HALLIBURTON NUS CORPORATION
PITTSBURGH, PENNSYLVANIA

APPROVED FOR SUBMISSION BY:

JOHN TREPANOWSKI, P.E.
CLEAN PROGRAM MANAGER
HALLIBURTON NUS CORPORATION
WAYNE, PENNSYLVANIA

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EXECUTIVE SUMMARY

PURPOSE OF THE REMEDIAL INVESTIGATION

Operable Unit 3 (OU-3) is defined as contaminated groundwater in overburden and shallow bedrock attributable to Area C. Area C includes Site 4 (north runway landfill), Site 8 (fire-fighting training area), and the area located between these two Installation Restoration Program (IRP) sites. The objectives of the OU-3 Remedial Investigation (RI) were to:

- Assess shallow groundwater impacts attributable to Area C. This investigation focused solely on shallow groundwater; other media and source area studies for Area C are being addressed under separate investigations.
- Further define the hydraulic characteristics of the Stockton Formation in the vicinity of Area C to evaluate contaminant distribution and migration.
- Gather the necessary data with which to support a Feasibility Study (FS) for OU-3.

SITE BACKGROUND INFORMATION

Site 4 - North Runway Landfill

Site 4 is a grass-covered area covering 7 acres just north of the main runway along Kirk Road and south of the patrol road. The site is the largest of the NAWC Warminster waste disposal locations; it is less than 100 feet from the edge of the facility boundary. This site reportedly was operated from 1966 to 1970. Up to seven trenches on the site reportedly were used to dispose of non-industrial solid waste, paints, waste oils, waste metals, construction debris, solvents, and sewage sludge from the sewage treatment plant. Some drainage from this area intersects the unnamed tributary of Little Neshaminy Creek, off site to the north of Kirk Road, near Munro Park. Several offsite residences are present within 200 feet of Site 4.

Each trench at the site was reported to be 12 feet wide, 1,000 feet long, and 9 feet deep. Approximately 25,000 cubic yards of wastes were deposited, and each trench had a potential capacity of 3,600 cubic yards. It is not known whether wastes were segregated prior to disposal or were placed randomly into each trench.

Site 8 - Fire-Fighting Training Area

The fire-fighting training area (Site 8) is found in an open grassy area within the fenced area of the NAWC Warminster property. The site is located north of the main airstrip at the northeastern end of an abandoned runway. Directly to the northeast are Kirk Road and Werner Park.

The training area consisted of a 75- by 75-foot portion of the runway surrounded on three sides by a double berm. The berms were approximately 3 to 5 feet high. The site was used for fire training exercises from 1961 to February 1988. Typically, flammable materials were poured on the runway, ignited, and extinguished to simulate fire-fighting procedures.

An apparent drum storage area was observed in 1981, adjacent to the bermed fire training area. Materials reportedly kept within this drum storage area were lubricants and transformer coolant oils.

By 1988, the double soil berms had been removed. NAWC Warminster personnel reported that these berms, along with residue, trapped liquids, and soil from eroded areas, had been analyzed and removed. The removed material was deposited in an area adjacent to Site 8, and the site itself was regraded.

In the past, surface water was observed to collect within this area. Typically, 6 to 12 inches of water ponded at the site. Aviation fuel, scrapped cars and aircraft, and other debris were reportedly stored and burned within Site 8. An estimated 3,000 gallons of aviation fuel were disposed annually at Site 8. Historical aerial photos indicate that two areas on the abandoned runway were used as burn areas. The older area was about 100 feet southwest of the newer area.

Other Potential Sites Within Area C

Based on a review of aerial photos and on field observations, two other areas of potential concern have been identified. Historical aerial photos documented the presence of a pistol range within Area C in the past. The range was located approximately 800 feet south (upgradient) of Site 8. There is evidence of standing water within the pit dug for the range in at least one set of historic photos. The range is no longer active, has been filled in, and no obvious evidence of it exists in it's former location.

The other area of potential concern is a small complex of maintenance buildings located approximately 400 feet southeast of Site 8. These buildings appear to be used primarily for storage and maintenance of lawn care equipment, based on field observations.

Neither area had been studied during any of the past investigations at NAWC Warminster.

SCOPE OF PREVIOUS GROUNDWATER INVESTIGATIONS FOR AREA C

Previous Investigations for Site 4

Ten monitoring wells were installed at Site 4 during previous investigations, which included a Phase I and a Phase II Remedial Investigation (RI). These wells comprise five well clusters, each consisting of an overburden well and a shallow bedrock well. The distribution of hydraulic head in these wells indicated that groundwater flow in both zones is generally to the north. Low levels of chlorobenzenes and phthalates were found in these wells during the Phase II RI.

A soil-gas field screening program and a limited subsurface soil investigation program (three confirmation borings) were performed within Site 4 during the Phase II RI. The soil-gas survey found slightly elevated VOC readings of between 1 and 15 ppm at nine stations scattered throughout Site 4. Subsurface soil samples taken at the locations of the elevated soil-gas readings detected single occurrences of PCE, ketones (acetone and 2-butanone), ethylbenzene, xylenes, PAHs, and a polychlorinated biphenyl (PCB).

Previous Investigations for Site 8

Samples collected during the Phase II RI from two of the four monitoring wells (46 and 47 feet deep) in this area contained PCE at 1J and 3J μg/L.

A soil-gas field screening program and a limited surface and subsurface soil program were performed within Site 8 during the Phase II RI. The soil-gas program found elevated readings adjacent to the older, upgradient training area. Surface and subsurface soil samples taken at the soil-gas hot spot revealed elevated levels (above background) of polycyclic aromatic hydrocarbons (PAHs) in the surface soil; the PAH levels in the subsurface soil were roughly comparable to background levels. Only one chlorinated solvent (1,4-dichlorobenzene) was detected in one surface soil sample.

Off-Base Groundwater Contamination

In June 1993, the Navy tested off-Base wells located north of Area C, including the residential wells on Kirk Road that lie adjacent to NAWC Warminster and between Sites 4 and 8. The results of this sampling program revealed that six of the residential wells on Kirk Road contained levels of tetrachloroethene (PCE) at concentrations at or above 5 μg/L, which is the MCL for PCE. The results ranged from 5.3 to 314 μg/L.

In response, the Navy provided water treatment systems to residences in the affected area. In addition, these residences are being connected to public water. A review of the existing data for Sites 4 and 8 did not indicate that either site was an obvious potential source of this contamination.

SCOPE OF THE OU-3 REMEDIAL INVESTIGATION

The information generated during the previous investigation, historic site information, and discussions between the Navy, EPA, state, local consultants, and Halliburton NUS were used to develop the scope of work for the OU-3 field investigation. The OU-3 remedial investigation field work consisted of the drilling, logging, installation, and development of 17 monitoring wells and one piezometer at nine locations, the sampling and analysis of 30 monitoring wells, and the measurement of hydraulic heads for all wells within Area C.

MAJOR FINDINGS

Based on the findings of the OU-3 RI field investigation and data evaluation, the following are the conclusions reached regarding groundwater conditions within and adjacent to Area C:

- Groundwater flow across Area C occurs primarily within the bedrock underlying the area; fractures within the rock mass are the principal migration pathways for groundwater in bedrock.
- The bedrock underlying the study area consists of alternating layers of fine-grained and coarse-grained rock units that are laterally persistent on a local scale. The rock units generally strike to the east-northeast and dip to the north-northwest at about 9 degrees.
- Shallow groundwater flow across Area C is to the north, in the general direction of the slope of ground surface topography and bedrock dip.
- A low concentration plume of PCE has been identified in the northwestern portion of Area C, extending off site to residential wells north of Kirk Road. No obvious source of the PCE has been identified, as there was little or no PCE detected in wells installed within the potential source areas (Site 8, firing range, maintenance area) identified to data near the plume.
- Due to the relatively low concentrations of PCE found near Kirk Road and in potential source areas, it is considered likely that there is no well defined, high-concentration source area for the

PCE. The pattern of contamination observed to date is suggestive of several discrete, minor releases rather than a long-term, higher intensity source.

- The presence of a significant upward head differential between the deeper bedrock flow zone monitored within Area C, and the shallow bedrock zone is expected to act to prevent contaminant migration to the deeper portions of the bedrock aquifer.

- Carcinogenic risks related to Area C are approximately 10^{-5} for current potential users of groundwater in offsite areas and are driven by the PCE. Calculated risks are within the U.S. EPA target risk range.

- Carcinogenic risks related to Area C are approximately 10^{-4} for potential future receptors and are driven by arsenic and beryllium, which are naturally occurring and appear to be found at representative concentrations below background levels for the area.

- Noncarcinogenic risks are driven by antimony, manganese, thallium, and arsenic. Antimony, manganese, and arsenic are naturally occurring and appear to be found at representative concentrations below background levels for the area. There was only one positive detection of thallium (unfiltered sample only) in Area C.

1.0 INTRODUCTION

In response to Contract Task Order No. 159 under Contract N62472-90-D-1298, Halliburton NUS Corporation (HNUS) is submitting this Remedial Investigation (RI) report for the Naval Air Warfare Center (NAWC) (formerly the Naval Air Development Center), Warminster, Pennsylvania. This work is part of the Navy's Installation Restoration Program (IRP), which is designed to identify contamination of Navy and Marine Corps facilities resulting from past operations and to institute corrective measures as appropriate. IRP activities are typically performed in four distinct phases. The first phase consists of a Preliminary Assessment (PA) followed by a Site Inspection (SI). The third phase is a Remedial Investigation/Feasibility Study (RI/FS), which is intended to characterize physical and chemical parameters and risks associated with the facility. The last phase consists of remedial action designed to control and mitigate contamination. This report is prepared under Phase III IRP activities.

In addition to meeting the objectives of the Navy's IRP, the purpose of the RI is to meet the requirements of CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act of 1980), as amended by SARA (Superfund Amendments and Reauthorization Act of 1986). As such, the RI should investigate the nature and extent of contamination associated with all hazardous substance releases at the facility that are not regulated and are not being investigated under the authority of the Clean Air Act, Clean Water Act, the Resource Conservation and Recovery Act (RCRA), and other Federal laws.

Section 300.430(a)(1)(ii)(A) of the National Oil and Hazardous Substances Pollution Contingency Act (NCP) provides that hazardous substance facilities should generally be remediated in operable units when early actions are necessary or appropriate to achieve significant risk reduction quickly, when phased analysis or response is necessary or appropriate given the size or complexity of the site, or to expedite the completion of a total cleanup. Operable Unit 3 (OU-3) at NAWC Warminster has been identified to facilitate these objectives.

1.1 PURPOSE OF REPORT

The purpose of this report is to present the results of the groundwater-related Remedial Investigation conducted at NAWC Warminster for OU-3. Operable Unit 3 has been defined as contaminated groundwater in overburden and shallow bedrock attributable to Area C (including Sites 4 and 8 and adjacent areas). Data from this investigation is used to conduct a baseline risk assessment for groundwater, which is also included in the report. The risk assessment determines where unacceptable risks to human health have been

identified. The report also forms the basis for a feasibility study for OU-3 to evaluate remedial alternatives for identified groundwater contamination.

1.2 OVERVIEW OF IRP PROGRAM AT NAWC WARMINSTER

NAWC Warminster is listed on the National Priorities List (NPL). The NPL includes those sites that appear to pose the most serious risks to public health or the environment. The areas of concern identified to date include eight waste disposal sites originally identified under the IRP program. These eight sites are located on NAWC property and are as follows:

- Three waste burn and disposal pits (Sites 1, 3, and 6)
- Two sludge disposal pit area (Sites 2 and 7)
- Two landfills (Sites 4 and 5)
- One fire training area (Site 8)

Historically, wastes at the facility were generated during aircraft maintenance and repair, pest control, fire-fighting training, machine and plating shop operations, spray painting, and various materials research and testing activities in laboratories. These wastes included paints, solvents, sludges from industrial wastewater treatment, and waste oils. Table 1-1 summarizes the disposal history and types of waste deposited at these sites. None of the sites are currently used for waste disposal.

Although all sites are being investigated as part of the RI process, this report focuses on groundwater contamination in the overburden and shallow bedrock within Area C, which has been defined to include IRP Sites 4 and 8 as well as immediately surrounding areas. For NAWC Warminster, remedial actions are being implemented in phases as appropriate using operable units to manage problems and expedite the reduction of risks posed by the facility.

Three RI's (Phase I, Phase II, and a Focused RI for Groundwater) were conducted at the facility, including Area C, between October 1989 and May 1994. Phase I was performed between October 1989 and January 1991 by SMC Environmental Services Group (SMC Martin, 1991). Phase II was performed between May 1992 and September 1992 by HNUS (Halliburton NUS, 1992 and 1993a). The Area C portion of the Focused RI was conducted between January and May 1994 by HNUS to address groundwater-related data gaps that were not completely addressed during the earlier studies. A Restoration Advisory Board (RAB), which consisted of representatives of the Navy, the United States Environmental Protection Agency (EPA), the Pennsylvania Department of Environmental Resources (PADER), the Bucks County Health Department,

TABLE 1-1

SUMMARY OF WASTE MANAGEMENT AND SITE OPERATIONS
NAWC WARMINSTER, PENNSYLVANIA

Site No.	Dates of Operation	Types of Wastes	Method of Operation	Potential Hazards
1	1940 to 1955	Paints, oils, asphalt, roofing material, unspecified chemicals, firing range wastes	Burn pit within an eroded ravine	Various solvents, driers, pigments, PAHs, creosote, phenols, asbestos, binders, lead
2	1965 to 1970	Industrial wastewater sludges	2 disposal trenches	Biological wastes, heavy metals
3	1955 to 1965	Solvents, paints, roofing materials, and unspecified chemicals	Burn pit	Various solvents, driers, pigments, asbestos, binders
4	1966 to 1970	Non-industrial solid wastes, paints, waste oils, waste metals, construction debris, solvents, and sewage treatment sludge	7 disposal trenches	Various solvents, driers, pigments, lead, PAHs, biological wastes, heavy metals
5	1955 to 1970	Paints, solvents, scrap metal, and 30 drums of asphalt	6 to 8 disposal trenches	Various solvents, driers, pigments, creosote, phenols, PAHs
6	1960 to 1980	Paints, solvents, demolition wastes, waste oils, other flammable wastes, and grease trap wastes	Unknown number of disposal pits or trenches	Various solvents, driers, pigments, lead, PAHs
7	1950 to 1955	Industrial wastewater sludge	2 disposal trenches	Biological wastes, heavy metals
8	1961 to 1988	Aviation fuel, lubricants, coolants	Fire-fighting training area	PAHs, PCBs

Adapted from SMC Martin, 1991 (Tables 1-1 and 4.3-4).

Northampton Township, Warminster Township, Ivyland Borough, and Upper Southampton Township participated in the planning and review of these activities.

The results of the Phase I and Phase II studies are summarized in this section. A detailed discussion of the work performed during the focused RI for Area C groundwater forms the basis for the RI report.

1.3 FACILITY BACKGROUND AND HISTORY

This section describes NAWC Warminster and provides a brief synopsis of the facility's background and history. More detailed discussion is provided in the Phase II RI (Halliburton NUS, 1993a).

1.3.1 Facility Description

NAWC Warminster is located approximately 28 miles northeast of Philadelphia, mostly in Warminster Township, Bucks County, Pennsylvania. The facility can be found on the United States Geological Survey (USGS) Hatboro 7.5-minute topographic quadrangle map, a portion of which is reproduced as Figure 1-1. The total area of NAWC Warminster is approximately 840 acres. The facility lies in a populated suburban area surrounded by private homes, various commercial/industrial activities, and a golf course. On-Base areas include various buildings and other complexes connected by paved roads, the runway and ramp area, mowed fields, and a small wooded area.

The longest runway is generally located along the topographically highest area at the facility. Many of the primary facility buildings are located west of the airstrip, along Jacksonville Road. A housing development for military enlisted personnel is within the southeastern portion of NAWC Warminster. The on-Base wastewater treatment plant is located in the northwestern corner of the facility. NAWC Warminster has approximately 3,000 employees, and 1,000 people reside at the facility year round. The facility is located on a ridge, generally oriented east-west, with elevations ranging from 297 feet at the northwestern property boundary to 377 feet at the eastern boundary. Slopes are gentle and average 3 to 5 percent. The northern portion of the facility (about 65 percent) drains into small, unnamed tributaries of Little Neshaminy Creek. The remaining portion drains into unnamed tributaries of Pennypack Creek.

NAWC Warminster is underlain by the Stockton Formation, which provides water for more than 100,000 people within the vicinity of the facility. Local surface water bodies are used for recreation and industrial purposes.

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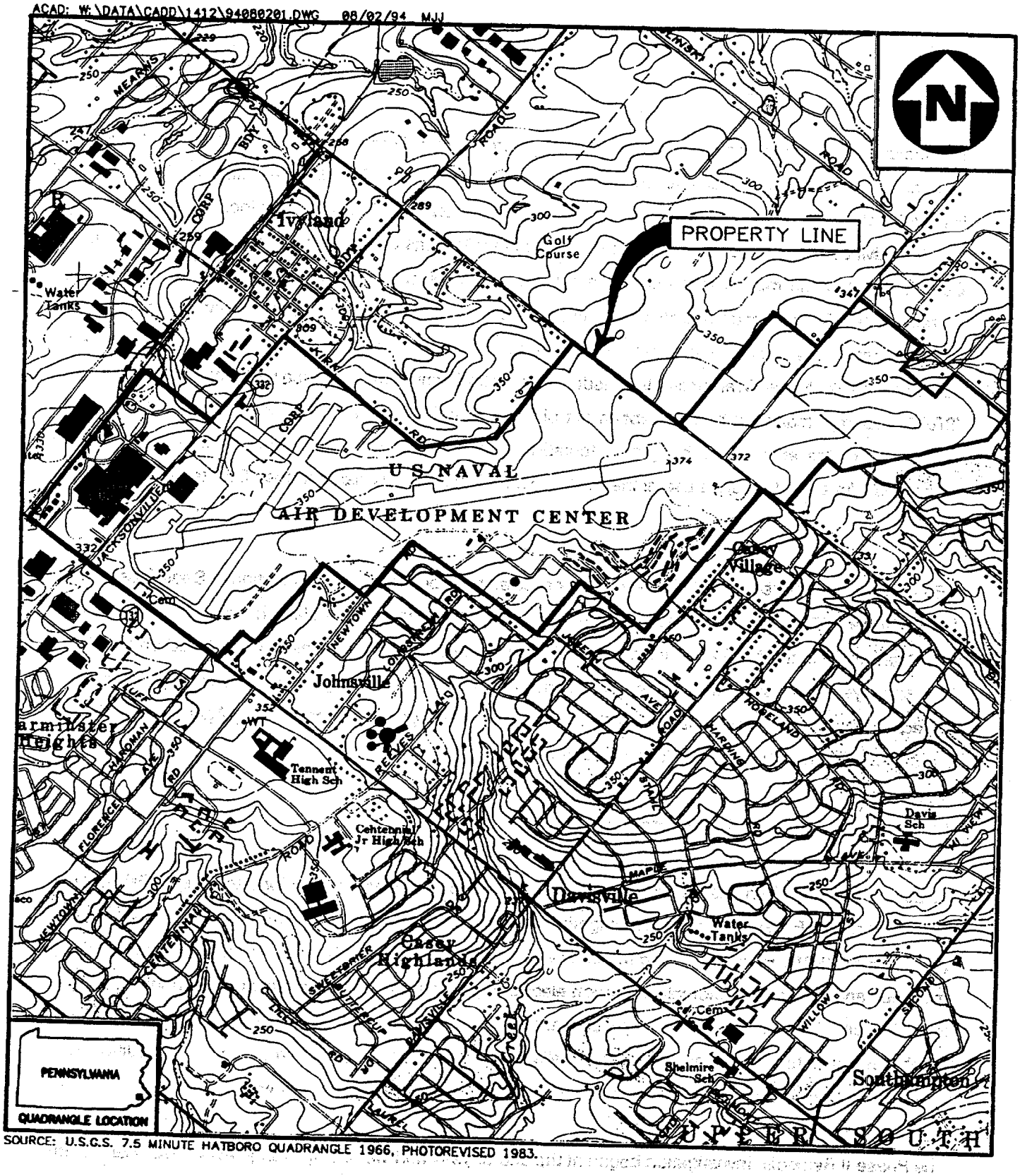

SOURCE: U.S.G.S. 7.5 MINUTE HATBORO QUADRANGLE 1966, PHOTOREVISED 1983.

SITE LOCATION MAP
NAWC WARMINSTER, PA

0 2000 4000
SCALE IN FEET

FIGURE 1-1

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R-06-94-2

1.3.2 Facility History

The facility was originally the location of Brewster Aeronautical Corporation, a manufacturer of military aircraft. In 1944, the Navy assumed full control of the Brewster plant. The Naval Air Modification Unit was installed at the Base to add design modifications to military aircraft produced at other locations. After World War II, activities at the Base were altered; in 1949, the facility was designated the Naval Air Development Center, and its main mission has been research, development, testing, and evaluation for Naval aircraft systems. NAWC Warminster has also conducted studies in anti-submarine warfare systems and software development. The facility name was changed to Naval Air Warfare Center, Aircraft Division, on January 1, 1992. NAWC Warminster is scheduled for realignment under the Base Realignment and Closure (BRAC) Program managed by the Department of Defense (DOD). This realignment, which is due to the downsizing of the entire DOD budget, is tentatively set for 1996; however, this timetable is still being developed. As such, the future use of the NAWC Warminster property has not been finalized at the time of this report.

EPA officially recognized the NAWC Warminster sites as possibly needing investigation in September 1979. In November 1979, EPA completed a PA. In 1980, the Department of the Navy began its environmental investigative work at NAWC Warminster. On October 4, 1989, NAWC Warminster was placed on the NPL. That same year, EPA submitted a draft Interagency Agreement to the Navy for formalizing and scheduling remedial activities. On September 20, 1990, the Navy and EPA signed a Federal Facility Agreement outlining a process for conducting CERCLA activities at NAWC Warminster.

1.3.3 Environmental Investigations

To date, the NAWC Warminster sites are being addressed by the Navy in three long-term remedial phases. The study for the Phase I Remedial Investigation began at the end of 1989 and was completed in April 1991 (SMC Martin, 1991). Phase I involved mapping volatile organic compounds (VOCs) in soil-gas and detecting magnetic and conductive anomalies through electromagnetic surveys. Approximate site boundaries were identified and investigation of site contamination was made through soil borings, installation of new overburden and shallow bedrock monitoring wells, and groundwater sampling and analysis. In addition, test pits were excavated, local wells were inventoried, and a fracture-trace analysis was conducted.

The Phase II Remedial Investigation began at the end of 1991 and was completed in April 1993 (Halliburton NUS, 1992 and 1993a). Phase II involved installing additional overburden and shallow bedrock monitoring wells, sampling and analyzing groundwater, and evaluating aquifer characteristics through water level monitoring and a pumping test. Four off-Base wells were also sampled. At the end of Phases I and II, the

Navy and EPA selected a remedy for contaminated shallow groundwater attributable to Sites 1, 2, 3, 5, 6, and 7 at the Base. This was the first CERCLA remedial action selected for NAWC Warminster.

After Phase II was completed, the Navy initiated other environmental investigations to more fully determine the nature and extent of groundwater contamination attributable to NAWC Warminster. In April 1993, the Navy began a comprehensive well testing program for nearby wells in the vicinity of the Base (Halliburton NUS, 1993b). In addition, further groundwater investigation activities at the Base began in October 1993 for Area B (Sites 5, 6, and 7), January 1994 for Area C (Sites 4 and 8) and February 1994 for Areas A (Sites 1, 2, and 3) and Area D (Site 9). The RI field work for Area C groundwater was completed in May 1994. The Navy is currently conducting additional environmental studies at the Base and is planning to investigate other media associated with NAWC Warminster under the RI/FS process, including groundwater in deep bedrock aquifers, wastes, soils, sediment and surface water. As such, the Navy will conduct further studies at Area C to address contamination in other media.

1.3.4 Other Operable Units

In April 1993, the Navy completed RI and FS reports for Operable Unit 1 (OU-1), which consists of contaminated groundwater attributable to Areas A and B in overburden and shallow bedrock (Halliburton NUS, 1993a). In September 1993, the Navy and EPA finalized and signed a Record of Decision (ROD) for OU-1. The ROD selected an interim remedial action for contaminated groundwater attributable to the facility in overburden and shallow bedrock aquifers. A design for the interim groundwater extraction and treatment system will be finalized by the end of June 1994.

In April 1993, the Navy initiated an off-Base well testing program in the vicinity of the Base. Between April and August 1993, the Navy sampled more than 250 off-Base residential, commercial, and municipal wells (Halliburton NUS, 1993b). Most nearby wells were unaffected by the Base, however, levels of some volatile organic compounds found in residential wells exceeded federal drinking water standards. To facilitate a response action for this off-Base contamination, the Navy and EPA created a second operable unit, OU-2, which is defined as contaminated groundwater associated with residential wells located on Kirk Road north of Area C and residential wells in the vicinity of the Casey Village area southeast of Area B. The Navy has conducted a CERCLA removal action for OU-2, installing water treatment systems in residences affected by groundwater contamination and hooking up residents in the vicinity of Casey Village and Kirk Road to a public water supply system.

1.4 Area C HISTORY AND DESCRIPTION

This section describes the history and description of the known and potential sites within Area C. The general site features within Area C are shown in Figure 1-2.

1.4.1 Site 4 - North Runway Landfill

Site 4 is a grass-covered area just north of the main runway along Kirk Road and south of the patrol road. The Site is located at approximately the mid-point of the runway. The location of Site 4, based on the delineation of waste material, is shown in Figure 1-2.

The Site is the largest of the NAWC Warminster waste disposal locations; it is less than 100 feet from the edge of the facility boundary. This Site reportedly was operated from 1966 to 1970. Up to seven trenches on the site reportedly were used to dispose of non-industrial solid waste, paints, waste oils, waste metals, construction debris, solvents, and sewage sludge from the sewage treatment plant. Some drainage from this area intersects the unnamed tributary of Little Neshaminy Creek, off site to the north of Kirk Road, near Munro Park. Several offsite residences are present within 200 feet of Site 4.

Each trench at the Site was reported to be 12 feet wide, 1,000 feet long, and nine feet deep. Approximately 25,000 cubic yards of wastes were deposited, and each trench had a potential capacity of 3,600 cubic yards. It is not known whether wastes were segregated prior to disposal or were placed randomly into each trench.

1.4.2 Site 8 - Fire-Fighting Training Area

The fire-fighting training area (Site 8) is found in an open grassy area within the fenced area of the NAWC Warminster property. The site is located north of the main airstrip at the northeastern end of an abandoned runway (Figure 1-2). Directly to the northeast are Kirk Road and Werner Park. Werner Park is bounded by the small creek formed from runoff from Site 8 and the unnamed creek that begins near Site 4. The site is about 500 feet from the NAWC Warminster fence and 1,000 feet from Base housing. A cement drainage culvert receives runoff from the site and discharges this runoff to an unnamed tributary of Little Neshaminy Creek to the north. Scattered single-family houses are located northeast of Werner Park. Immediately northwest of Werner Park and northeast of Site 8 are single-family houses.

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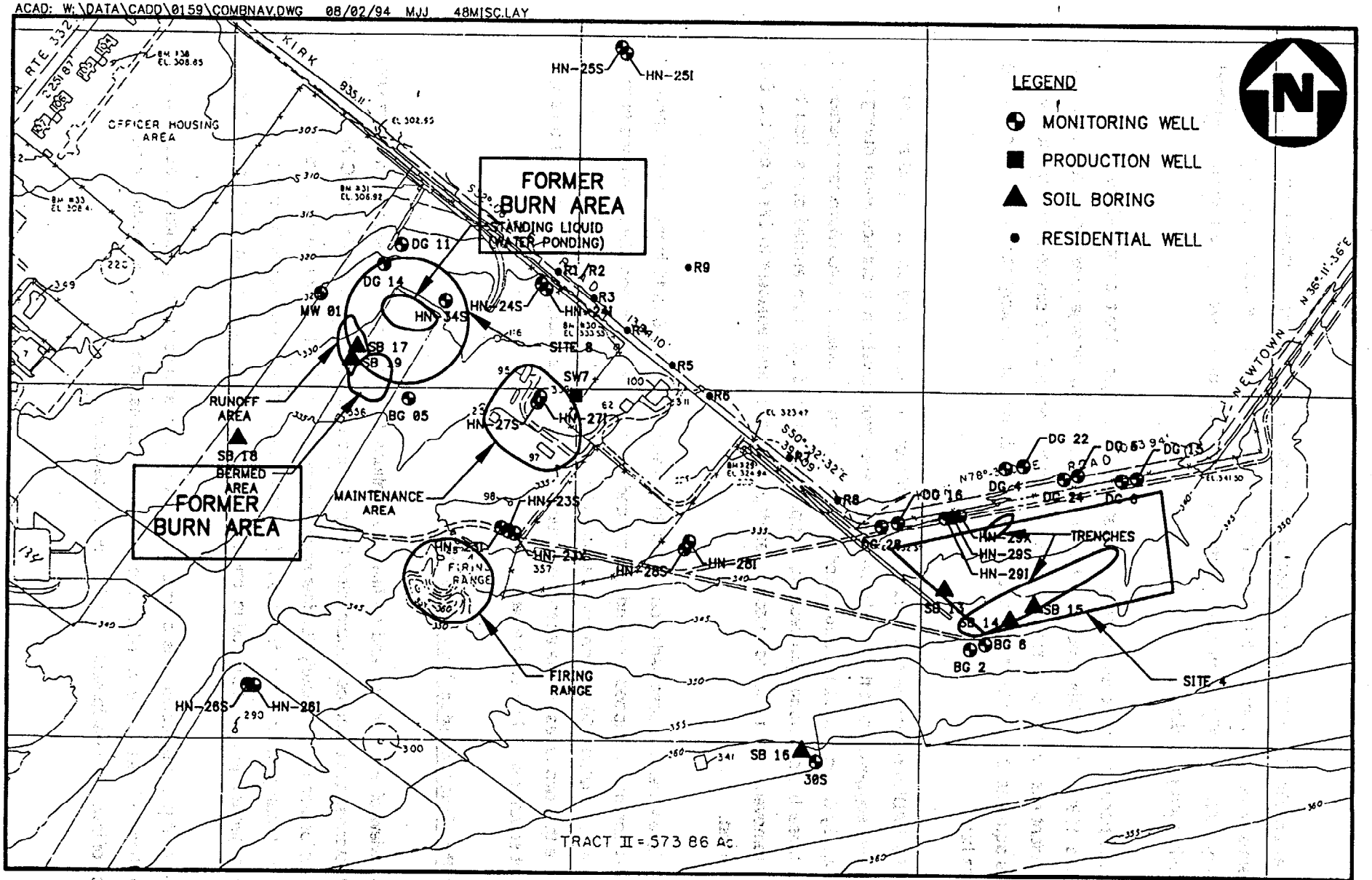

AREA C
(SITES 4, 8 AND MISCELLANOUS AREAS)
HISTORIC FEATURES
NAWC WARMINSTER, PA

FIGURE 1-2

Halliburton NUS CORPORATION

The training area consisted of a 75- by 75-foot portion of the runway surrounded on three sides by a double berm. The berms were approximately 3 to 5 feet high. The site was used for fire training exercises from 1961 to February 1988. Typically, flammable materials were poured on the runway, ignited, and extinguished to simulate fire-fighting procedures.

During 1981, JRB personnel noted an apparent drum storage area adjacent to the bermed fire training area (JRB Associates, 1981). Materials reportedly kept within this drum storage area were lubricants and transformer coolant oils. In the past, residents along a tributary north of the site complained about white foam (perhaps aqueous film-forming foam) floating in the neighborhood tributary after fire-fighting training exercises were held.

In October 1986, PADER recommended excavation and disposal of residue and contaminated soils at the Site. PADER also suggested that the area be lined to protect groundwater and surface water during fire-fighting training. By October 1988, the double soil berms had been removed. NAWC Warminster personnel reported that these berms, along with residue, trapped liquids, and soil from eroded areas, had been analyzed and removed. The removed material was deposited in an area adjacent to Site 8, and the Site itself was regraded.

In the past, surface water was observed to collect within this area. Typically, 6 to 12 inches of water ponded at the site. Aviation fuel, scrapped cars and aircraft, and other debris were reportedly stored and burned within Site 8. An estimated 3,000 gallons of aviation fuel were disposed annually at Site 8. Historical aerial photos indicate that two areas on the abandoned runway were used as burn areas. The older area was about 100 feet southwest of the newer area.

1.4.3 Other Potential Sites Within Area C

Based on a review of aerial photos and on field observations, two other areas of potential concern were identified. Historical aerial photos documented the presence of a pistol range within Area C in the past. The range was located approximately 800 feet south (upgradient) of Site 8, as shown in Figure 1-2. There is evidence of standing water within the pit dug for the range in at least one set of historic photos. The range is no longer active, has been filled in, and no obvious evidence of it exists in its former location.

The other area of potential concern is a small complex of maintenance buildings located approximately 400 feet southeast of Site 8 (Figure 1-2). These buildings appear to be used primarily for storage and maintenance of lawn care equipment, based on field observations.

Neither area has been studied during any of the past investigations at NAWC Warminster, nor has any historic information been found suggesting that these areas may be significant sources of contamination.

1.5 PREVIOUS INVESTIGATIONS RELEVANT TO Area C

1.5.1 Previous Investigations for Site 4

Ten monitoring wells were installed at Site 4 during previous investigations (see Figure 2-1 for well locations and Table 2-1 in Section 2.0 for well construction summaries). These wells comprise five well clusters, each consisting of an overburden well and a shallow bedrock well. The distribution of hydraulic head in these wells indicates that groundwater flow in both zones is generally to the north. Low levels of organic compounds were found in these wells during the Phase I (SMC Martin, 1991) and Phase II (Halliburton NUS, 1992 and 1993a) remedial investigations. In particular, 1,2,4-trichlorobenzene was detected at 2 μg/L and 1,2-dichlorobenzene was detected at 3 μg/L in one downgradient shallow bedrock well (DG-16). In addition, phthalates were detected in several wells at levels between 0.2 μg/L and 2.0 μg/L; their occurrence does not form a recognizable pattern.

A soil-gas field screening program and a limited subsurface soil investigation program (three confirmation borings) were performed within Site 4 during the Phase I and Phase II RI. The soil-gas survey found slightly elevated VOC readings of between 1 and 15 ppm at nine stations scattered throughout Site 4. These elevation readings did not appear to form any recognizable pattern other than that they were nearly completely restricted to sample taken within surface depressions that mark the former trench locations (eight of the nine detections). The GC indicated that acetone and an unknown compound were responsible for the elevation soil-gas readings. Acetone, however, was also detected in blank samples, making its actual detection at Site 4 questionable. Subsurface soil samples taken at the locations of the elevated soil-gas readings detected single occurrences of tetrachloroethene (PCE), ketones (acetone and 2-butanone), ethylbenzene, xylenes, PAHs and a polychlorinated biphenyl (PCB). All compounds except the PCE were detected in single samples; the sample containing the PCE (at 7.75 μg/kg) also contained only very low concentrations of polynuclear aromatic hydrocarbons (PAHs), ranging from 38.2 μg/kg to 50.2 μg/kg.

SMC Martin (1991) noted that the topography within Site 4 appeared to be hummocky, presumably due to differential settling within the landfill. Color variations in the grass cover were noted to create a banded or striped pattern. These color variations were approximately the same sizes and orientations as the landfill trenches.

1.5.2 Previous Investigations for Site 8

Four monitoring wells were installed at Site 8 prior to the OU-3 field investigation (MW-01, BG-05, DG-14, and DG-11). The locations of these wells are illustrated in Figure 2-1; the construction details are listed in Table 2-1. Wells BG-5 and DG-14 were sampled during the Phase I RI (well MW-01 had not yet been installed). Wells BG-5, DG-14, and MW-01 were sampled during the Phase II RI. Well DG-11 was not sampled during either investigation because it is obstructed above the water table.

The Phase I results revealed PCE concentrations of 3-J μg/L and 1-J μg/L in wells BG-5 and DG-14, respectively. The results were qualified as estimated (J) because the analytical values were below the contract required detection limit (CRQL). PCE was not detected in either well during the Phase II RI. Well MW-1, sampled only during Phase II, contained PCE at 2.0 μg/L.

A soil-gas field screening program and a limited surface and subsurface soil program were performed within Site 8 during the Phase II RI. The soil-gas program found elevated readings adjacent to the older, upgradient training area. No samples were obtained beneath the asphalt/concrete of the former runway. The gas chromatograph (GC) indicated that the elevated readings were caused by acetone and two unknown compounds. Acetone and one of the two unknown compounds were also present in blank samples, however. The GC did not identify volatile compounds characteristic of fuel products (e.g., benzene, toluene, xylene). Surface and subsurface soil samples taken at the soil-gas hot spot revealed elevated levels (above background) of polycyclic aromatic hydrocarbons (PAHs) in the surface soil; the PAH levels in the subsurface soil were roughly comparable to background levels. A chlorinated solvent (1,4-dichlorobenzene) was detected in only one surface soil sample at a level of 43 μg/kg.

1.5.3 Off-Base Groundwater Contamination

In June 1993, the Navy tested off-Base wells located within 3,000 feet north of Area C for VOCs, including the residential wells on Kirk Road that lie adjacent to NAWC Warminster and between Sites 4 and 8 (HNUS, 1993b). The results of this sampling indicated that six wells on Kirk Road (see Figure 2-1) contained PCE at concentrations ranging from 5.3 μg/L to 31.4 μg/L. A supply well in Werner Park, sampled in the spring of 1994, contained PCE at a concentration of 14.0 μg/L. In addition, the shallow and deep wells at one residence (R1) contained TCE at 0.1J μg/L (estimated) and 0.4J μg/L (estimated), respectively. The supply well in Werner Park also contained chlorobenzene (7.0 μg/L), carbon tetrachloride (16.0 μg/L) and bromodichloromethane (2.0 μg/L). A review of the existing data for Sites 4 and 8 did not indicate that either site was an obvious potential source of this contamination.

1.6 GOALS OF THE Area C INVESTIGATION

The goals of the OU-3, as described in the Focused RI for Groundwater Work Plan Addendum (HNUS, 1994a), are to:

- Determine the nature and extent of groundwater contamination in the vicinity of Area C.
- Further define the hydraulic characteristics of the Stockton Formation in Area C.
- Develop the hydrogeologic data base necessary to conduct an effective feasibility study for OU-3.
- Perform a focused feasibility study to evaluate remedial options for shallow groundwater in Area C.

In addition to these objectives, potential risks related to groundwater usage will be quantified in this RI.

Further source area characterization studies are also planned for Area C. These plans have not been finalized to date and will be performed in conjunction with other source area studies. This RI and FS will focus on groundwater impacts only and will not address source area characterization and remediation.

1.7 REPORT ORGANIZATION

Section 1.0 discusses the purpose, scope, and objectives of this RI report and provides a brief background summary for NAWC Warminster. Section 2.0 details the field activities performed during the RI for Area C. This section describes the objectives and methods of each investigative task conducted at this area. Section 3.0 presents the Base-wide and Area C physical characteristics based on existing literature, previous investigations, and recently developed information and conclusions derived from the RI work. Section 4.0 describes the nature and extent of shallow groundwater contamination discovered at Area C during the field investigation. Section 5.0 summarizes the routes of migration and persistence of contaminants found in shallow groundwater at Area C. Section 6.0 determines the potential risks posed by Area C shallow groundwater to human health and the environment given the limiting factors of contaminant fate and transport. Finally, Section 7.0 summarizes the findings of the RI and provides recommendations for further Area C groundwater characterization or remediation efforts.

Several appendices have been enclosed as separate volumes of the RI report; these present specific results of the field investigations (e.g., monitoring well logs, risk calculations).

2.0 AREA C REMEDIAL INVESTIGATION

2.1 SCOPE OF INVESTIGATION

The scope of the OU-3 Remedial Investigation field work consisted of the drilling, logging, installation, and development of 17 monitoring wells and one piezometer at nine locations, the sampling and analysis of 30 monitoring wells, and the measurement of hydraulic heads for all wells within Area C.

The tasks performed during the OU-3 investigation are described in the Letter Addendum to the Focused Remedial Investigation for Groundwater (Halliburton NUS, 1994a). In order to expedite the groundwater investigation, the planned source area investigation work (test pit excavations) described in this document has not yet been conducted. This work has been deferred to the upcoming Phase III RI currently being planned.

2.1.1 Previous Well Installation Information

Previous hydrogeological investigations of Sites 4 and 8 have concentrated solely on the shallow (generally <50 feet in depth) groundwater beneath this area. Prior to the present study, a total of 14 monitoring wells (ten at Site 4 and four at Site 8) have been installed to investigate the groundwater at these areas (see Figure 2-1). The depths of these wells range from 10 to 85 feet, with a median depth of 22 feet and a mean depth of 33 feet. Table 2-1 provides construction details for these wells.

The Navy began the sampling and analysis of off-Base wells in the vicinity of NAWC Warminster in April 1993 (Halliburton NUS, 1993b). The testing included the residential wells along Kirk Road, located immediately north and adjacent to Area C (see Figure 2-1). The analytical results for these wells revealed PCE concentrations ranging from nondetect to 31 μg/L. While the construction details for these wells are limited (see Table 2-2), the available data indicate the presence of groundwater contamination in this area at subsurface depths generally deeper than the previous depth of investigation for groundwater contamination in this area.

2.2 OU-3 MONITORING WELL INSTALLATION

Permanent monitoring wells were installed at various locations during the OU-3 Remedial Investigation in order to further quantify and delineate the groundwater contamination discovered during the previous

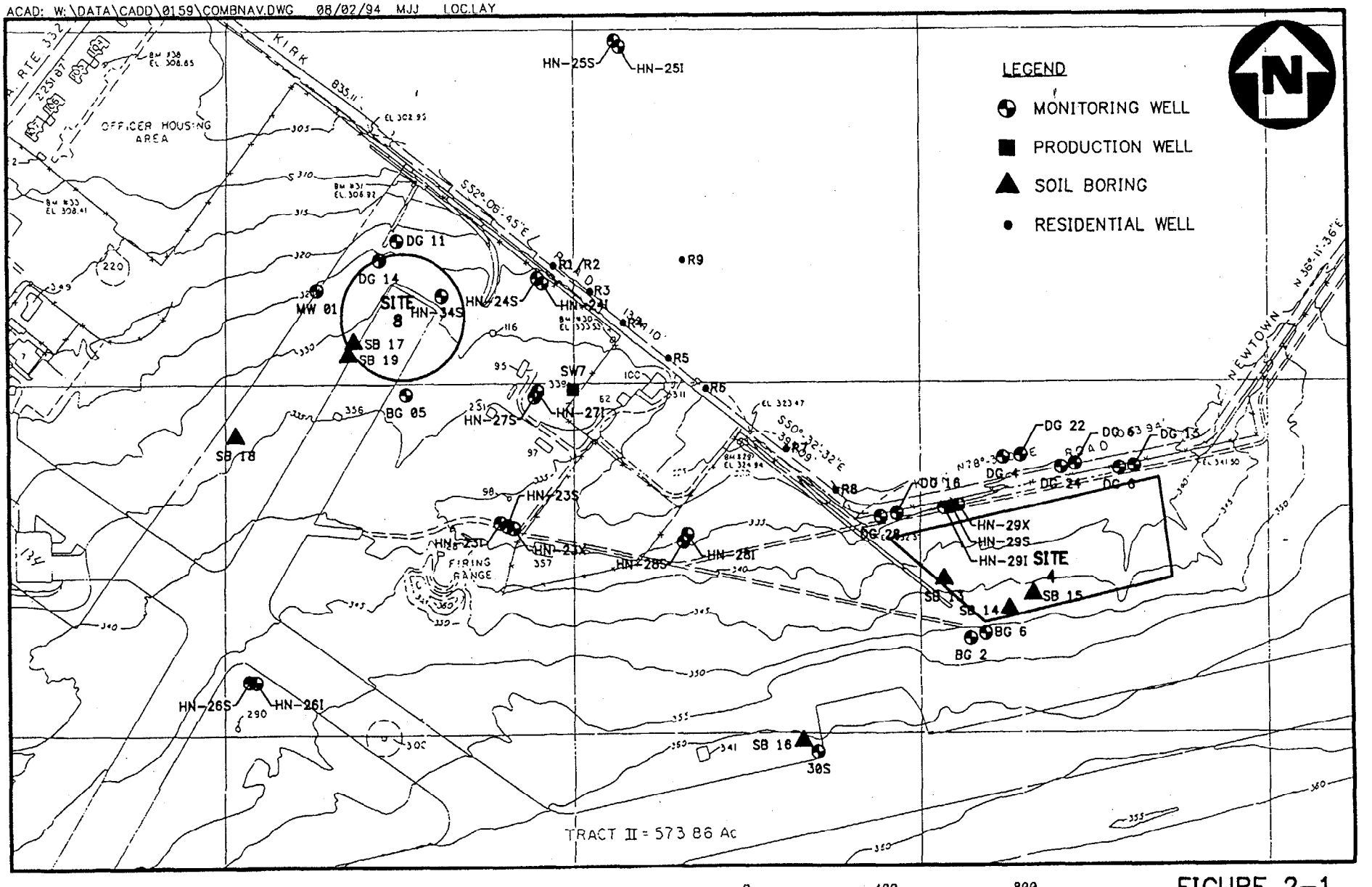

FIGURE 2-1

AREA C
MONITORING WELL LOCATIONS
NAWC WARMINSTER, PA

Halliburton NUS CORPORATION

TABLE 2-1

AREA C
WELL CONSTRUCTION SUMMARY
NAWC WARMINSTER, PENNSYLVANIA

Well	Elevation (ft)		Total Depth (ft)	Monitored Interval[a]	Well Diameter (inch)	Estimated Yield (gpm)	Well Type
	Ground	Top of Casing					
PREVIOUSLY INSTALLED WELLS							
BG-2	N/A	351.04	15.5	7.5 - 14.7	2	NA	overburden
BG-5	N/A	335.53	47	17 - 47*	6	2	bedrock
BG-6	N/A	351.76	22	15 - 22*	6	1	bedrock
MW-1	N/A	326.65	85	18 - 85*	6	2	bedrock
DG-4	N/A	330.17	15.5	6.85 - 14.04	2	NA	overburden
DG-5	N/A	336.76	17.5	7.44 - 16.00	2	NA	overburden
DG-6	N/A	335.10	17.5	9.0 - 17.1	2	NA	overburden
DG-11[b]	N/A	321.57	16.8	12.6-16.8	2	N/A	overburden
DG-14	N/A	327.11	46	18 - 46*	6	0.5	bedrock
DG-15	N/A	339.13	22	18 - 22*	6	0.5	bedrock
DG-16	N/A	334.59	38	18 - 38*	6	1	bedrock
DG-22	N/A	331.57	61	20 - 61*	6	0.5	bedrock
DG-24	N/A	336.84	43	22 - 43*	6	0.5	bedrock
DG-28	N/A	334.25	10	3 - 10	4	<0.5	overburden
FOCUSED RI WELLS							
HN-23X	334.13	336.33	12	6 - 12	2	<1	overburden
HN-23S	334.33	335.88	75	49-62	2	10	bedrock
HN-23I	333.93	336.88	151	125 - 151	2	5	bedrock
HN-24S	325.76	327.26	205	45 - 65	2	<.5	bedrock
HN-24I	326.39	327.96	125	95 - 115	2	1	bedrock
HN-25S	302.88	302.68	145	26 - 49	2	<1	bedrock
HN-25I	303.28	303.08	83	69 - 83	2	3	bedrock

TABLE 2-1 (Continued)
AREA C
WELL CONSTRUCTION SUMMARY
NAWC WARMINSTER, PENNSYLVANIA

Well	Elevation (ft)		Total Depth (ft)	Monitored Interval[(a)]	Well Diameter (inch)	Estimated Yield (gpm)	Well Type
	Ground	Top of Casing					
FOCUSED RI WELLS (Continued)							
HN-26S	345.17	345.00	53	28 - 53	2	3	bedrock
HN-26I	345.55	345.40	205	119 - 151	2	3	bedrock
HN-27S	334.39	335.78	105	18 - 52	2	1	bedrock
HN-27I	333.81	335.65	158	145 - 158	2	2	bedrock
HN-28S	334.18	336.73	84	53 - 68	2	<1	bedrock
HN-28I	332.43	334.83	184	154 - 172	2	7	bedrock
HN-29X	334.53	335.83	10	4 - 10	2	<1	overburden
HN-29S	334.58	336.41	65	38 - 59	2	6	bedrock
HN-29I	334.38	336.08	145	122 - 138	2	6	bedrock
HN-30S	360.63	360.29	102	68 - 83	2	-	bedrock
HN-34S	329.00	328.76	105	87 - 105	2	3	bedrock

* Well completed as open borehole in bedrock

(A) The monitored interval is measured from ground surface and is equivalent to the sand-packed interval for wells installed with a screen and riser pipe. For the wells completed as open boreholes in bedrock (designated by an asterisk [*]), the monitored interval is equivalent to the length of open borehole.

(B) Well obstructed above water surface.

TABLE 2-2

FOCUSED REMEDIAL INVESTIGATION FOR GROUNDWATER
AREA C HYDROGEOLOGIC INVESTIGATION
CONSTRUCTION DETAILS FOR RESIDENTIAL WELLS ALONG KIRK ROAD
ADJACENT TO AREA C
NAWC WARMINSTER, PENNSYLVANIA

Well	Borehole Depth (ft)	Casing Depth (ft)	PCE Concentration (μg/L)[1]
R-1	20	NA	10
R-2	130	NA	16
R-3	116	NA	7.5
R-4	110	NA	31
R-5	125	65	17
R-6	NA	NA	5.3
R-7	NA	NA	0.3
R-8	NA	NA	ND
R-9	NA	NA	14

1 Off-Base Well Inventory and Sample Analysis Report for Naval Air Warfare Center; Warminster, Pennsylvania (Draft). Halliburton NUS Corporation, September, 1993 (except R9, which was sampled Spring, 1994).

NA Not Available
ND Not Detected

investigations. Monitoring well clusters were installed upgradient and downgradient of Sites 4 and 8 in order to evaluate the impact of these sites on the local groundwater quality. Additional monitoring well clusters were installed between Sites 4 and 8 to obtain hydrogeological data for that area to fully define both the horizontal and vertical components of groundwater flow throughout Area C and to identify any other potential sources of contamination.

A total of 17 monitoring wells and one piezometer were installed during the remedial investigation. The location of these monitoring wells is illustrated in Figure 2-1. All of the wells were installed with either an Ingersoll Rand T-4 or T-3 drilling rig. The monitoring wells were installed either as single wells or as part of a well cluster at each location. The well clusters consisted of shallow- and intermediate-depth bedrock wells at all locations and overburden wells at selected locations. The number of wells installed at a location was dependent on the presence of any pre-existing wells at the location and on the data gaps identified during the scoping of the investigation.

The monitoring wells were designed and installed to monitor the most significant water-bearing zone within a designated target interval. The highest yielding zone typically was identified as the most significant water-bearing zone within a target interval. If the interval contained several zones of similar yields, the results of the geophysical program (described below) were used to select the most appropriate interval to be screened.

In general, the target intervals were from the ground surface to the top of bedrock for the overburden wells, from the top of bedrock to a subsurface depth of 75 feet for the shallow bedrock wells, and from a subsurface depth of 75 to 150 feet for the intermediate bedrock wells. The target intervals were based upon the goal of obtaining discrete samples in order to define the vertical extent of contamination and upon the observation from both the current and previous investigations that the Stockton Formation beneath NAWC Warminster generally consists of very highly fractured bedrock to a subsurface depth of approximately 50 to 60 feet, and a less fractured, more competent bedrock below this depth. These target intervals, however, were used only as general guidelines. The actual depth of each monitoring well was based upon the depth that significant water-bearing zones were encountered. For example, HN-34S (projected to be a "shallow" monitoring well) monitors the subsurface interval from 87 to 105 feet because no significant water bearing zones were encountered in the shallower portion of the borehole.

The boreholes for each monitoring well were drilled until a significant water bearing zone within the appropriate target interval was encountered. If no significant zones were encountered, the boreholes were drilled a maximum of 55 additional feet in an attempt to encounter prospective intervals to be monitored. The lithologies encountered during the drilling of the boreholes and the depth(s) and approximate yields of

the water-bearing zones were recorded by a Halliburton NUS field geologist. Copies of the field boring logs are included in Appendix A.

Geophysical tools were run in each borehole to determine various subsurface conditions, including lithology, fractured intervals, water-entry or exit zones, and vertical direction of groundwater flow. The overall purpose of running the geophysical instruments was to assure that each well would be completed over the optimal or most appropriate stratigraphic interval. For the deepest borehole at each location, the geophysical logs generated included the caliper log, the natural gamma log, the single-point resistivity log, the fluid temperature and fluid resistivity logs, and in selected boreholes, the brine tracing log. Generally, only the caliper log was run in the shallower bedrock borehole(s) to identify or confirm the depths of the fractured intervals as noted in the drilling log. A downhole video camera was run in selected boreholes to observe the lithology and to identify the nature of the fractured intervals and/or water-bearing zones as identified through the various geophysical logs.

The monitoring wells were constructed with 2-inch-diameter, flush-joint and threaded Schedule 40 PVC well casing and 2-inch-diameter, Schedule 40, 0.020-inch slotted well screen fitted with a bottom cap. The space between the bottom of the borehole and the bottom of the screen (if any) was sealed with bentonite to the bottom of the desired monitoring interval, and with No. 2 quartz sand from that point to the bottom of the screen. The annular space between the well screen and the borehole in most wells was packed with No. 2 quartz sand to the top of the desired monitoring interval. For wells screened through wide fractures (as identified by the caliper and video logs), the annular space between the well screen and the borehole wall was packed with pea gravel to a height of about 2 feet above the top of the screen, and No. 2 quartz sand to a height of about 4 feet above the top of the screen. The annular space from the top of the sand pack to the bottom of the surface casing was sealed with bentonite, and the annular space inside the surface casing was sealed with a bentonite-cement grout. Well construction details are summarized in Table 2-1; well construction diagrams are included in Appendix B.

The monitoring wells were developed a minimum of 48 hours after installation. The groundwater temperature, pH, conductivity, and turbidity were monitored during development. These parameters were recorded on well development log sheets, which are included in Appendix C. The flowing artesian wells (HN-23I, HN-26I, HN-28I, and HN-29I) were developed by uncapping the wells and allowing them to flow. The remainder of the wells were developed with either a submersible or centrifugal pump. The drawdown in these wells was monitored with an electronic sounding device to ensure that the pumping rate did not exceed the yield of the well. The amount of water developed from the wells was dependent upon their yield and the time needed for the monitored parameters to stabilize. In general, the wells were developed until

the parameters from three consecutive samples taken at 15-minute intervals fell within 10 percent of one another.

2.3 GROUNDWATER SAMPLING

Sampling and analysis of groundwater was conducted to determine the nature and extent of contamination in the vicinity of Area C and to provide data for use in the risk assessment and the evaluation of remedial action alternatives for the feasibility study. The groundwater sampling was conducted from April 5 through April 7, 1994. A total of 30 monitoring wells were sampled, including the 17 newly installed screened wells (2 overburden, 8 shallow bedrock, and 7 intermediate bedrock), and 13 pre-existing wells (4 screened overburden wells and 9 shallow, open-borehole bedrock wells). All monitoring wells within Area C were sampled except for well DG-11 at Site 8, which is obstructed above the water table.

The groundwater sampling and analysis program and sampling procedures are described in the Work Plan Addendum (Halliburton NUS, 1994a) and the Quality Assurance Project Plan (Halliburton NUS, 1994b) for Focused Remedial Investigation of Groundwater. All wells were purged prior to sampling. Wells with yields of 1 gallon per minute or greater were purged of a minimum of three well volumes of groundwater and until the monitored parameters (pH, temperature, conductivity) of three consecutive samples of purge water fell within 10 percent of one another. The pumping rate was monitored to assure that the wells were not purged at a higher rate than the natural yield of the formation. Wells with yields of less than 1 gallon per minute were purged dry and allowed to recover overnight to the pre-pumping static water level prior to sampling. All wells were sampled with decontaminated, stainless steel bottom-loading bailers.

All groundwater samples were analyzed for low-concentration volatile organics and Target Analyte List (TAL) metals (total and dissolved phases). Selected samples were analyzed for Target Compound List (TCL) semivolatile organics and PCBs/pesticides. Table 2-3 identifies the analyses performed for each particular groundwater sample. Field measurements collected during sampling were pH, temperature, and specific conductivity. These parameters were recorded on sample log sheets, which are included in Appendix D.

Groundwater samples were stored in coolers and submitted daily to a Naval Energy and Environmental Support Activity (NEESA)-approved laboratory using Contract Laboratory Program (CLP) methods. Quality control samples, including field duplicates, trip blanks, and rinsate blanks, were collected and analyzed as required by NEESA Level D sampling protocol and as specified in the Work Plan Addendum and Quality Assurance Project Plan for Focused Remedial Investigation for Groundwater.

TABLE 2-3

GROUNDWATER SAMPLING PARAMETERS FOR MONITORING WELLS
NAWC WARMINSTER, PENNSYLVANIA

Cluster Location	Well	Analysis			
		Low-Concentration Volatile Organics	TCL Semi-volatile Organics	TAL Metals (Total and Filtered)	PCBs/ Pesticides
HN-23	HN-23X	X	X	X	X
	HN-23S	X	X	X	X
	HN-23I	X	X	X	X
HN-24	HN-24S	X	X	X	X
	HN-24I	X	X	X	X
HN-25	HN-25S	X	X	X	
	HN-25I	X	X	X	
HN-26	HN-26S	X	X	X	X
	HN-26I	X	X	X	X
HN-27	HN-27S	X	X	X	X
	HN-27I	X	X	X	X
HN-28	HN-28S	X	X	X	X
	HN-28I	X	X	X	X
HN-29	HN-29X	X	X	X	X
	HN-29S	X	X	X	X
	HN-29I	X	X	X	X
HN-34	HN-34S	X	X	X	X
---	MW-1	X		X	
---	DG-14	X		X	
---	BG-5	X		X	
---	BG-2	X		X	
---	BG-6	X		X	
---	DG-28	X	X	X	X
---	DG-16	X	X	X	X
---	DG-4	X		X	
---	DG-22	X		X	
---	DG-5	X		X	
---	DG-24	X		X	
---	DG-6	X		X	
---	DG-15	X		X	

The analytical results of the groundwater sampling are summarized and discussed in Section 4. Appendix E contains the complete analytical results for the groundwater sampling performed during the OU-3 field investigation.

2.4 WATER-LEVEL MEASUREMENTS

Two comprehensive rounds of water levels were obtained from the Area C monitoring wells during the recent investigation, on May 11th and May 18th. Water levels were obtained from a total of 31 wells. The water levels were obtained using a calibrated M-Scope, marked to 1/100th of a foot, and were taken from marked points on the top of each well casing. Each comprehensive round of water levels was obtained within a time period of 2 to 3 hours, to minimize short-term water level fluctuation effects.

In addition, a partial round of water levels was taken, for the intermediate depth wells only, on June 3, 1994. This partial round of water levels was needed due to the existence of flowing artesian conditions in some of the intermediate wells. For the first two rounds of water levels, accurate water level measurements of the flowing artesian wells could not be made as two of the wells flowed at levels higher than the 10-foot-long extensions available for the wells. For the partial round of water levels, a water-tight cap with a 15-psi pressure gauge was used to measure the water levels in the flowing artesian wells, and an M-scope was used to obtain water levels for the intermediate wells with static water levels below the top of the casing. The pressure measurements for the flowing wells were converted into hydraulic head measurements by multiplying the pressures (in psi) by 2.31, to get the corresponding head in feet of water.

Table 2-4 presents the water level data obtained during the field investigation.

TABLE 2-4

AREA C
MONITORING WELL WATER LEVEL DATA
NAWC WARMINSTER, PENNSYLVANIA

Well	Reference Elevation[1]	Depth to Water (5/11/94)	Water Elevation (5/11/94)	Depth to Water (5/18/94)	Water Elevation (5/18/94)	Monitored Depth Interval[2]
BG2*	351.04	5.35	345.69	5.49	345.55	10.4-14.7
BG5	335.53	15.14	320.39	15.53	320.00	17-47
BG6	351.76	6.09	345.56	6.25	345.51	15-22
MW1	326.65	15.90	310.75	16.28	10.37	18-85
DG4*	330.17	2.62	327.55	2.90	327.27	9.8-14.1
DG5*	336.76	6.88	329.88	7.11	329.65	12.5-16.8
DG6*	335.10	8.29	326.81	8.55	326.55	12.8-17.1
DG14	327.11	17.85	309.26	18.23	308.88	18-46
DG15	339.13	8.42	330.71	8.66	330.47	18-22
DG16	334.59	7.22	327.37	7.56	327.03	18-38
DG22	331.57	3.79	327.78	4.04	327.53	20-61
DG24	336.84	8.15	328.69	8.38	328.46	22-43
DG28*	334.25	7.15	327.10	7.53	326.72	5-10
HN23X	336.33	6.75	329.68	7.34	328.99	7-12
HN23S	335.88	9.23	326.65	9.40	326.28	49-62
HN23I	336.88	FLOWING	>337	+ 6.12[3]	343.00[3]	125-151
HN24S	327.26	13.78	313.48	14.94	312.32	45-65
HN24I	327.96	14.89	313.07	13.61[3]	314.35[3]	95-115
HN25S	302.68	8.55	294.13	8.94	293.74	26-49
HN25I	303.08	9.28	293.80	10.34[3]	292.74[3]	69-82

TABLE 2-4 (Continued)
AREA C
MONITORING WELL WATER LEVEL DATA
NAWC WARMINSTER, PENNSYLVANIA

Well	Reference Elevation[1]	Depth to Water (5/11/94)	Water Elevation (5/11/94)	Depth to Water (5/18/94)	Water Elevation (5/18/94)	Monitored Depth Interval[2]
HN26S	345.00	13.77	331.23	14.22	330.78	28-53
HN26I	345.40	FLOWING	>345	0.40[3]	345.00[3]	119-151
HN27S	335.78	15.26	320.52	15.82	319.96	18-52
HN27I	335.65	8.41	327.24	8.63[3]	327.02[3]	145-158
HN28S	336.73	6.69	330.04	6.78	329.95	53-68
HN28I	334.83	FLOWING	>335	+ 14.90[3]	349.73[3]	154-172
HN29X*	335.83	7.67	328.16	8.04	327.79	5-10
HN29S	336.41	8.69	327.72	8.96	327.45	38-59
HN29I	336.08	FLOWING	>337	+ 14.78[3]	350.86[3]	122-138
HN30S	360.29	8.65	351.64	9.95[3]	350.34[3]	68-83
HN34S	328.76	16.34	312.42	16.20	312.56	87-105

* Overburden well

[1] Top of well casing, ft mean sea level
[2] Feet below ground surface
[3] Water levels obtained 06/03/94

3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

Several environmental studies concerned with the NAWC Warminster sites and/or surrounding areas have been completed over the last 12 years. A number of these studies, including JRB Associates (1981 and 1983), Sloto and Davis (1983), Satterthwaite (1984), and Earth Technology Corporation (1985a and 1985b), have provided information on local surface features, soils, meteorology, surface water hydrology, demography and land use, and hydrogeology.

A description of the physical characteristics of NAWC Warminster has been prepared on the basis of published information, reports of previous site studies, and information obtained and interpreted during the course of the RI. Section 3.0 provides information related to both general and local physical characteristics.

3.1 METEOROLOGY

The climate of the area is humid continental and is modified by the Atlantic Ocean. Temperatures average 76°F (24.4°C) in July and 32°F (0°C) in January. The average daily temperature for the NAWC location is 53.3°F (11.8°C). Precipitation averages 42.5 inches per year (106.25 cm per year), and snow fall averages 22 inches per year (55 cm per year). The distribution of precipitation is fairly even throughout the year. The relative humidity for the site averages 70 percent. The mean wind speed for this area is 9.6 mph with a prevailing direction being west-southwest (NAWC Warminster Emergency Response Plan, August 13, 1990).

3.2 SURFACE WATER HYDROLOGY AND TOPOGRAPHY

NAWC Warminster is situated on an upland area divided between two local drainage basins, the Little Neshaminy Creek Basin on the north and the Southampton Creek Basin on the south. The northern 65 percent of the facility (including Area C) drains toward the north through several swales and storm sewers into small unnamed tributaries of Little Neshaminy Creek. The southern 35 percent of the facility drains toward the south to the headwaters of Southampton Creek, a tributary of Pennypack Creek. Both local drainage basins lie within the regional drainage basin of the Delaware River. Several of the tributaries of Little Neshaminy and Southampton Creeks originate at, or near, the outfall points of culverts adjacent to the facility boundary. Various studies conducted on the Base have revealed that no areas within NAWC Warminster are included in the 100-year or 500-year floodplains.

A wetlands assessment of the wetlands along the unnamed tributary of Little Neshaminy Creek (see Figure 3-1) was conducted as part of the investigation (Halliburton NUS, 1994c). The results of this assessment are discussed in Section 3.8 (Ecology at Area C).

NAWC Warminster is located on a local topographic high. The crest of a local hilltop trends east-west within the facility and is roughly coincident with the location of the main runway. Surface topography across Area C slopes away from the main runway to the north, precluding surface water flow onto Area C from surrounding properties. Slopes range from nearly level to 8 percent and average from three to 5 percent. Surface elevations range from a high of approximately 380 feet mean sea level near the eastern end of the main runway to a low of approximately 310 feet along Kirk Road, in the northwest corner of Area C.

3.2.1 Hydrology at Site 4

An unnamed tributary of Little Neshaminy Creek is located north of Site 4, in Munro Park. This stream originates at the base of the storm sewer drain east of Site 4 and runs east to west through Munro Park immediately north of residences along Kirk Road. During base flow conditions, this stream appears heavily silted and has an estimated maximum flow rate of seven to 10 gpm. The uppermost part of this stream is small and intermittent and during dry periods, water in the stream tends to be limited to pool areas. The stream channel is well developed despite the low or intermittent flow rates. Channel width is 3 to 5 feet and channel depth is 1 to 2 feet. Sediments in the stream are primarily sands and cobbles in run areas and sands and silts in pools.

3.2.2 Hydrology at Site 8

Site 8 is drained by a concrete swale that discharges directly to an intermittent stream through a culvert beneath Kirk Road north of the site. The intermittent stream is channelized and flows to the north for approximately 750 feet until it joins with the unnamed tributary of Little Neshaminy Creek that originates near Site 4.

The intermittent stream was dry during base flow conditions observed during Phase I investigation sediment/surface water sampling. During the Phase II investigation, there was no surface water flow within the intermittent stream; however, pools of standing water were evident within the channel. This indicates that most surface water flow in this stream takes place during and shortly after precipitation.

No springs or bedrock outcrops were observed at or adjacent to Site 8.

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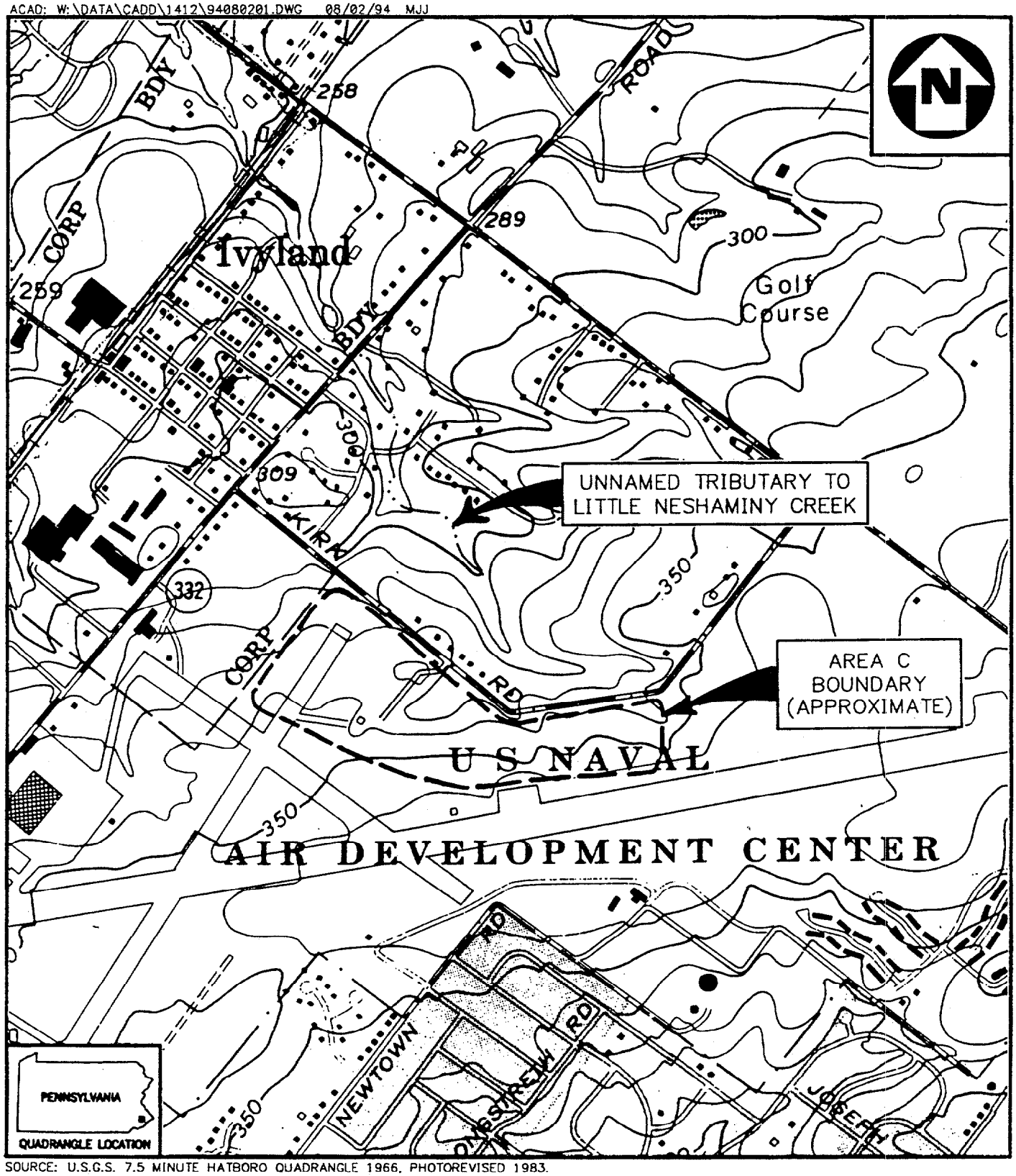

SOURCE: U.S.G.S. 7.5 MINUTE HATBORO QUADRANGLE 1966, PHOTOREVISED 1983.

AREA C SURFACE WATER
AND DRAINAGE FEATURES
NAWC WARMINSTER, PA

0 1000 2000
SCALE IN FEET

FIGURE 3-1

Halliburton NUS
CORPORATION

3.3 SOILS

Soils observed within Area C during current and previous RI field work (SMC Martin, 1991; Halliburton NUS, 1992) ranged from 2 to 15 feet in thickness. Soil types observed included orange-red, brown and maroon-red mixtures of silt, clay, and sand, with the finer-grained soils dominant.

The U.S. Soil Conservation Service (SCS) has mapped the soils at Site 4 as Duncannon silt loam and Chalfont silt loam (United States Department of Agriculture, 1975). The Duncannon silt loam is reported to have moderate permeability, and the Chalfont silt loam is described as having slow permeability. Waste material such as wood, plastic, paper, metal, brick, and glass fragments, along with assorted general trash material, was discovered in site soils during previous investigation work. This indicates that some site soils have been reworked from their natural state.

SCS has mapped the soil at Site 8 as Urban land - Lansdale complex, indicating that these soils were reworked from their natural state.

3.4 REGIONAL GEOLOGY

NAWC Warminster is located in the Piedmont physiographic province, Triassic Lowlands section, of southeastern Pennsylvania. The province is extensive and gently undulating and generally slopes to the southeast. The land forms have been modified by erosion to form moderate slopes and gently rounded hills with a dendritic drainage pattern.

The bedrock underlying NAWC Warminster belongs to the late Triassic age Stockton Formation. The Stockton Formation is unconformably underlain by basement rocks of Ordovician to Precambrian age that outcrop approximately two miles south of the facility. The Stockton Formation is conformably overlain by the shale- and argillite-rich Lockatong Formation, also of late Triassic age, which crops out approximately 2.5 miles north of the facility.

Within the general area of NAWC Warminster, the beds of the Stockton Formation strike to the northeast and dip from 7 to 16 degrees northwest. The average dip of the beds is 12 degrees to the northwest. Based on outcrop width and an average dip of 12 degrees, the Stockton Formation is estimated to be approximately 2,200 feet thick beneath NAWC Warminster. The Stockton Formation is extensively faulted by small displacement normal faults and is cut by well-developed joint systems.

The Stockton Formation is composed of fine- to coarse-grained arkosic sandstone and conglomerate interbedded with shale and siltstone. These rocks are interpreted to have been deposited by coalescing alluvial fans that deposited sediment eroded from highlands to the south (Sloto and Davis, 1983). Throughout the Stockton Formation, units of varying lithology are irregularly interbedded, with coarse-grained units commonly overlying fine-grained units. Beds commonly pinch out or form gradational contacts with overlying or underlying beds over lateral distances greater than several hundred feet (Rima, et al., 1962).

The Stockton Formation is divided into lower arkose, middle arkose, and upper shale members. Detailed geologic mapping of these three members is not available within Bucks County where NAWC Warminster is located. However, projections from geologic maps one mile west of the facility in Montgomery County indicate that the facility is underlain by the middle arkose member of the Stockton Formation (Rima, et al., 1962).

The middle arkose member of the Stockton Formation consists of beds of fine- and medium-grained arkosic sandstone with interbedded red shale, siltstone, and very fine-grained red sandstone. Also contained within this member are a few beds of coarse-grained arkose. The arkosic sandstones are usually pale brown to pale red, gray, and pale orange. Beds of shale and siltstone are more common in the upper portion of this member, and coarser-grained units are more common in the lower portion. Many of the beds are weakly cemented and well sorted, accounting for relatively high porosity compared to the upper shale and lower arkose members of the Stockton Formation (Rima, et al., 1962). The thickness of the middle arkose member of the Stockton Formation at NAWC Warminster is unknown but is estimated to be approximately 500 feet near the southeastern boundary of the facility, increasing to between 1,500 and 2,000 feet thick near the northwestern boundary.

The lower arkose member of the Stockton Formation underlies the middle arkose member and is projected to crop out approximately 2,000 feet or more southeast of the facility. The lower arkose member is dominated by coarse-grained arkosic sandstone and conglomerate. Beds of medium-grained arkosic sandstone are common, although less abundant than coarser-grained units. The lower arkose member is estimated to be approximately 1,700 to 1,800 feet thick near NAWC Warminster (Rima, et al., 1962).

The upper shale member of the Stockton Formation is generally not present in the vicinity of NAWC Warminster but overlies the middle arkose member several miles northwest of the facility. The upper shale member consists of shale, siltstone, and fine-grained arkosic sandstone. In general, grain size decreases upward within this member, with beds of fine-grained sandstone most common in the lower portions.

A layer of saprolite (extensively weathered bedrock) commonly underlies the area soils and overlies the unweathered shale, siltstone, or sandstone bedrock of the Stockton Formation. The saprolite usually occurs at an approximate depth of 4 to 10 feet and was found to be between 8 and 25 feet thick during previous well installation at NAWC Warminster (JRB Associates, 1983).

A map and detailed discussion of the approximate locations and orientations of fracture traces in the NAWC Warminster area is provided in the Phase II RI Report (Halliburton NUS, 1993). No fracture traces were identified within Area C.

Joint sets within the Stockton Formation occur in a discernible pattern. According to Rima, et al. (1962), the most frequently occurring joint sets trend perpendicular and parallel to the strike of the bedding. Another commonly occurring joint set trends to the northwest at an angle of about 50 degrees from strike.

Near Area C, most identified fracture traces trended to the east-northeast and to the north-northwest, which generally correspond to the ENE strike and NNW dip of the bedrock.

3.5 AREA C GEOLOGY

The Stockton Formation underlying Area C consists of alternating lithologic units of predominantly gray and brown, fine-grained arkosic sandstone and red-brown siltstone/mudstone. Individual beds or defined sequences of rock units of predominantly one lithologic type range from a few feet to approximately 50 feet in thickness across the area. Major lithologic units can be traced over significant portions of Area C, although the thinner beds within a unit are often difficult to correlate and may pinch out over distances of several hundred feet.

Within Area C, a bedrock strike of north 70 degrees east and a dip of 9 degrees to the northwest were measured based on correlations that were made between geophysical logs from well borings. This strike and dip matches up well with regional information regarding the bedrock structure. The direction of slope of the ground surface across Area C generally mimics the direction of dip of the underlying bedrock; however, the beds dip more steeply than the ground surface. Based on projections made using the measured bedrock strike and dip, the lithologic units encountered at depth within the northern portion of Area C outcrop in or adjacent to the southern, topographically higher part of Area C. In particular, some of the deeper units encountered outcrop along the runway area at the top of the hill behind (south of) Area C.

Two cross sections were prepared to show geologic conditions within Area C. The cross sections are aligned as shown in Figure 3-2. These cross sections are generalized interpretations of the subsurface conditions, and are based on both boring logs and geophysical logs. The interpretations in some cases combine several individual beds of minor thicknesses into larger lithologic units where appropriate, based on the overall dominant characteristics of a given sequence. Cross section A-A' (Figure 3-3) is aligned approximately along bedrock strike, while cross section B-B' (Figure 3-4) is aligned approximately down-dip, along a bearing of N 13° E, or 33 degrees from the calculated dip direction of N 20° W.

Fractures were encountered at various depths in each well boring. Both the coarser-grained sandstone units and the fine-grained siltstones/mudstones were fractured to varying degrees. No generalizations regarding the frequency of fracturing relative to rock type have been identified, however the fractures in the sandstones generally were more likely to produce significant quantities of water than the siltstone/mudstone fractures. Both cross-cutting fractures and bedding plane fractures were identified through interpretations of drilling and geophysical logs, and borehole camera tapes.

No direct observations of fracture orientations were made due to the absence of any outcrops in the area; however, it is typical for well developed, systematic joint sets to occur within lithologic units along orientations parallel and perpendicular to bedrock strike, and at angles of 45 to 60 degrees from bedrock strike.

The surface of the bedrock within Area C is highly weathered for a depth of about 5 to 15 feet in general. Residual soils exist within the top few feet of ground surface. The soils gradually grade into weathered rock, then competent bedrock. The transition points are hard to precisely define with any certainty. Figure 3-5 shows the topography of the bedrock surface, based on interpretations of drilling log information. This surface has an overall northerly slope across Area C. A minor trough in the bedrock surface is located between Sites 4 and 8 within Area C. This trough corresponds to a subdued topographic low which extends off site to the north to the small stream that drains Area C.

3.6 REGIONAL HYDROGEOLOGY

The major groundwater production aquifer in the vicinity of NAWC Warminster consists of the fractured bedrock of the Stockton Formation. The middle arkose member of the Stockton Formation is considered to be the most productive bedrock aquifer in Bucks County. These rocks form a multi-aquifer system of relatively discrete water-bearing zones separated by thicker, less permeable zones. Transmissivity and groundwater movement within water-bearing zones are greater parallel to bedding than across bedding.

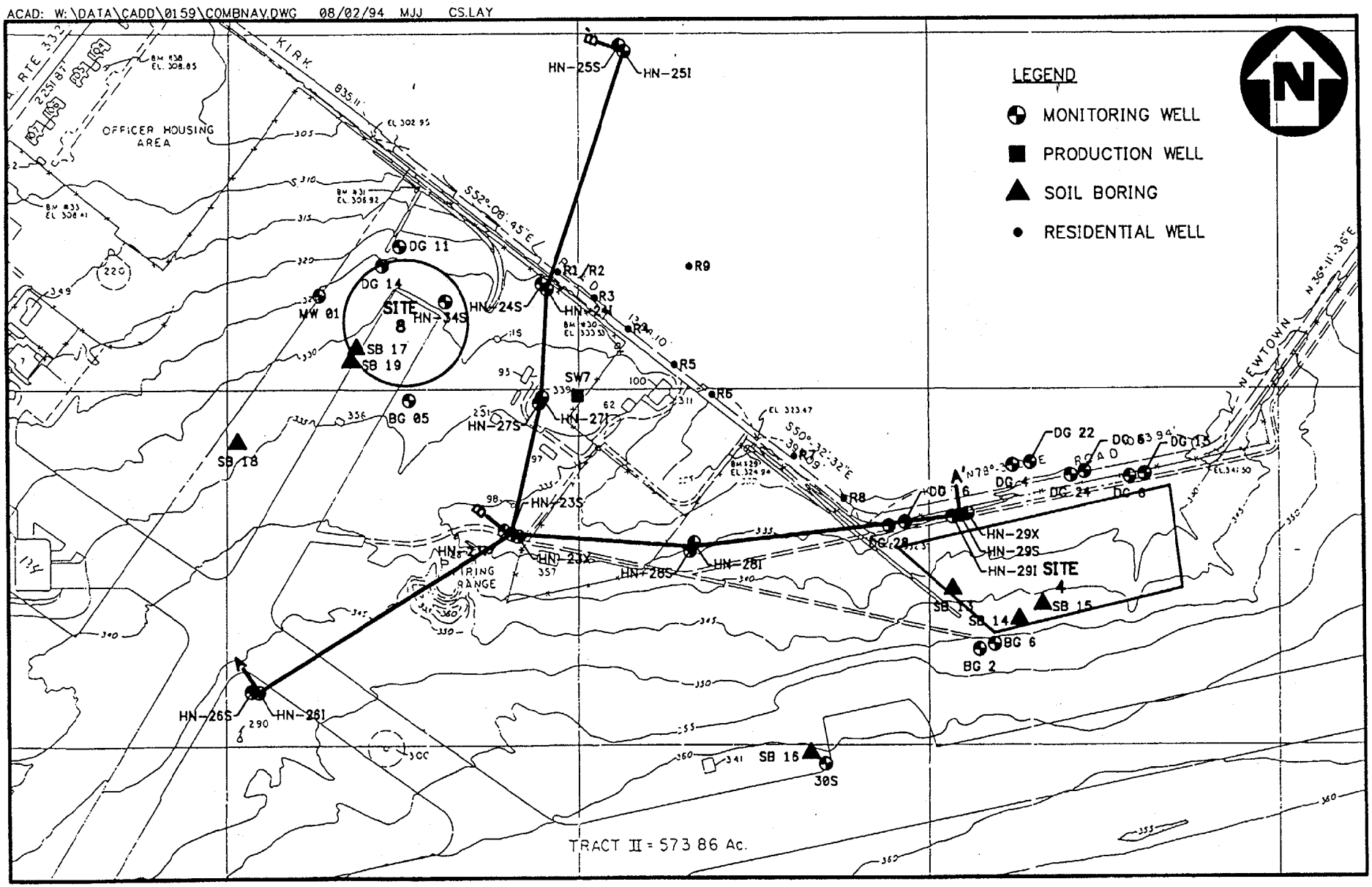

FIGURE 3-2

AREA C
CROSS SECTION LOCATION MAP
NAWC WARMINSTER, PA

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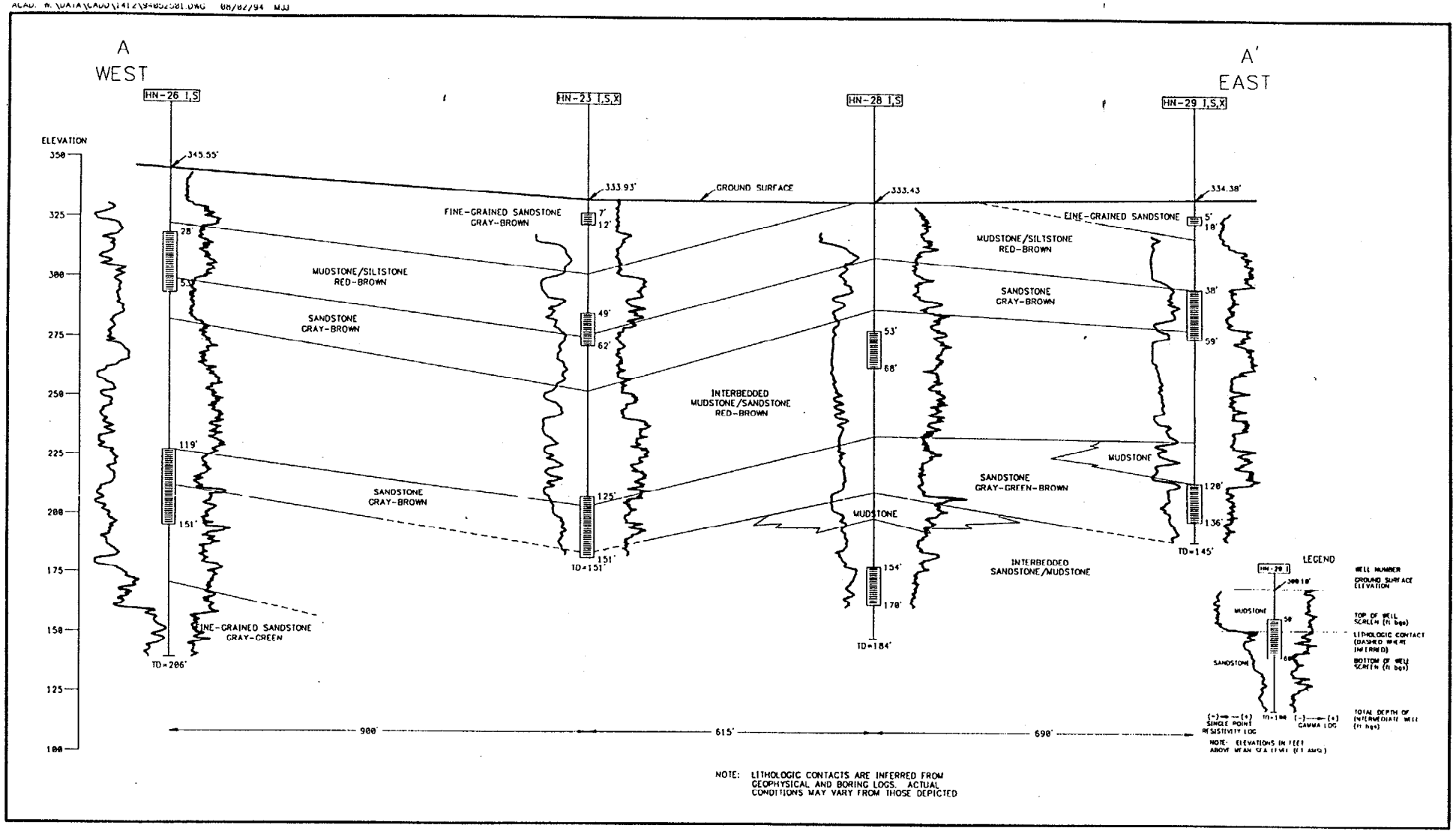

0 40 80
VERTICAL SCALE IN FEET

0 200 400
HORIZONTAL SCALE IN FEET

FIGURE 3-3

AREA C
GENERALIZED CROSS SECTION A-A
WARMINSTER

HALLIBURTON NUS
Environmental Corporation

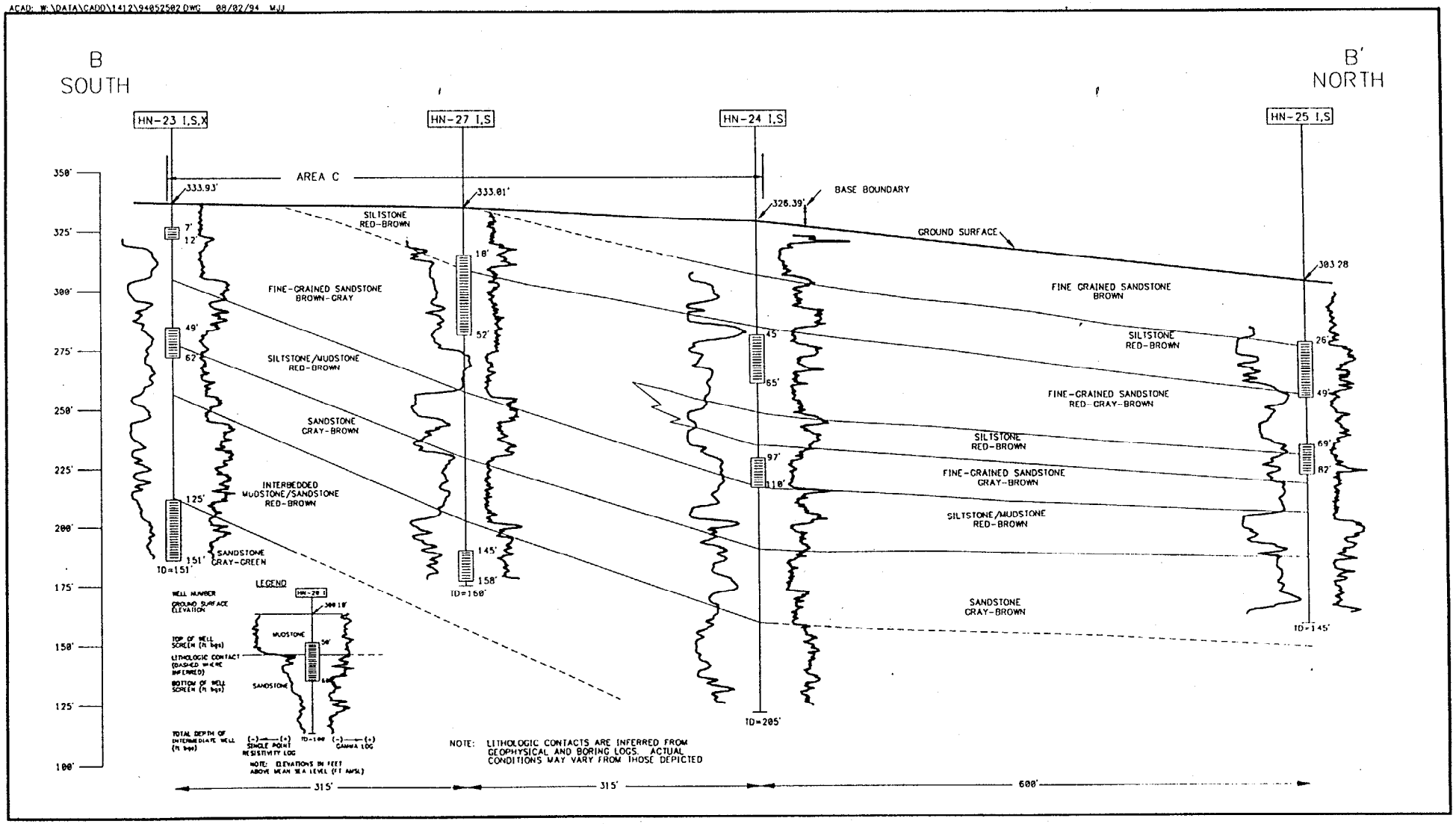

FIGURE 3-4

AREA C
GENERALIZED CROSS-SECTION B-B'
WARMINSTER

HALLIBURTON NUS
Environmental Corporation

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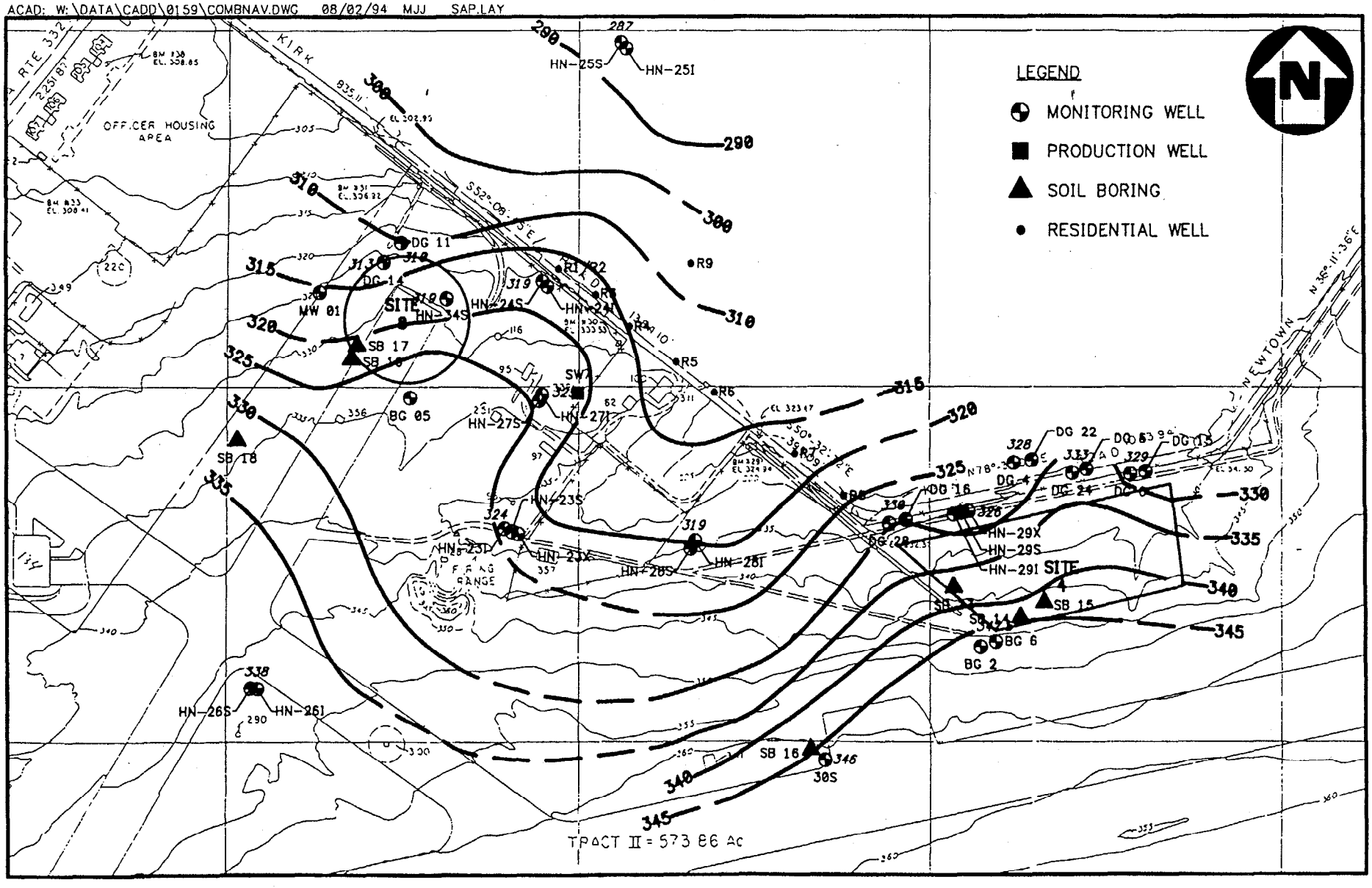

0 400 800
SCALE IN FEET

FIGURE 3-5

AREA C
BEDROCK/SAPROLITE
SURFACE TOPOGRAPHY
NAWC WARMINSTER, PA

Halliburton NUS CORPORATION

Vertical or nearly vertical fractures cutting across bedding and the weathering of various beds are expected to permit varying degrees of leakage between the main water-bearing zones, particularly near the surface. Groundwater in the Stockton Formation occurs locally under both confined and unconfined conditions.

Within water-bearing zones in the fine- and medium-grained sandstone of the Stockton Formation, groundwater is transmitted chiefly through fractures, joints, and bedding planes (secondary porosity). Primary porosity is minimal in these rock units. The shale and siltstone beds are commonly too fine grained to transmit large amounts of groundwater through primary porosity, and fractures and joints are typically not well developed in these fine-grained beds. Consequently, the shale and siltstone beds often act as confining layers to groundwater. Fracture permeability is generally better developed in the sandstone layers compared to the shale and siltstone layers of the formation. This, along with greater primary permeability, allows the sandstone layers to function as the most productive water-bearing units of the Stockton Formation.

The regional hydrogeology for the Stockton Formation in the NAWC Warminster area is that of a complex multi-aquifer system. The individual water-bearing zones of the Stockton Formation may belong to either of three different aquifer types. In descending order, these aquifer types include

- Overburden aquifer
- Shallow bedrock aquifer
- Deeper bedrock aquifer

These aquifer types are not interpreted to necessarily represent physically distinct units but to represent transitional zones that occur within the individual water-bearing units encountered at increasing depths.

The overburden aquifers consist of soil and saprolite (weathered bedrock) derived from erosion of the truncated edges of the inclined bedrock layers. They extend to depths of 15 to 35 feet with an average depth of 20 feet.

The shallow bedrock aquifers underlie the overburden aquifers and may extend to depths of 75 to 120 feet below the ground surface. The shallow bedrock aquifers are recharged by vertical percolation from the overburden aquifers and are the primary reservoir for groundwater storage in the Stockton Formation. The shallow bedrock aquifers are generally under water table conditions and occur within the unweathered and weathered shallow bedrock. The shallow bedrock aquifers may consist of numerous discrete water-bearing zones. Horizontal groundwater migration in response to regional gradients (controlled by topography or long-term well pumping) is significant in the shallow bedrock aquifers.

The deeper bedrock aquifers underlie the shallow bedrock aquifers and usually occur at depths greater than 75 to 120 feet below the ground surface. Water within them occurs under semi-confined or confined conditions. Leakage from one water-bearing unit to another occurs when there is a hydraulic head differential between the two units. Flow is from the unit with a higher hydraulic head to the unit with a lower head, and can be either upward or downward. Pumping effects can either amplify or reduce the leakage rate, depending on whether the pumping increases or decreases the head differential.

In general, the Stockton Formation behaves as a complex multiple aquifer system with low-permeability finer-grained units acting as confining layers for more highly permeable, coarser-grained units. Most deep wells in the Stockton Formation penetrate several major water-bearing zones and, if allowed to remain open through these zones, are multi-aquifer wells. The individual water-bearing zones of a given well generally have different hydraulic properties and different hydraulic heads. Therefore, the hydraulic head of a multi-aquifer well is a composite head of all the water-bearing zones in which it is completed. In wells that are completed in more than one major water-bearing zone, groundwater flows from water-bearing zones of higher hydraulic head to those of lower hydraulic head. These conditions have been documented by U.S.G.S. studies using geophysical logs and brine trace logs for numerous deep wells both within and in the vicinity of NAWC Warminster (Sloto, et al., 1992; Sloto, 1992).

3.7 Area C HYDROGEOLOGY

3.7.1 General Conditions

Groundwater in Area C occurs primarily within the bedrock (Stockton Formation) underlying the Base. Groundwater occurrence and movement through the Stockton Formation is primarily through secondary porosity (fractures) that exist within the rock mass. These fractures include both bedding plane partings and fractures that extend through individual rock units. In addition to the secondary porosity, there is likely some minor primary porosity, especially in the sandstone units, that contributes to groundwater occurrence and movement. In general, the coarser-grained (sandstone) units were observed to yield water more so than the finer-grained (siltstone and shale) units, although significant water-yielding fractures were encountered in all rock types.

The Stockton Formation is used as a domestic, municipal, and commercial water supply source in the local area. Approximately 15 domestic wells are located within 1,000 feet of Area C (about half of them downgradient of the area), and one municipal well is located within 1,500 feet of the area to the north.

Minor quantities of groundwater are also encountered within the lower portions of the thin veneer of soils and weathered rock overlying competent bedrock. The observed saturated thickness of the soils and weathered rock (i.e., overburden) within Area C ranged from approximately 3 to 12 feet. Due to the overall clayey nature and resulting low permeability of the overburden, groundwater movement through the overburden is likely to be restricted in comparison to the migration through the underlying fractures in bedrock. Limited hydraulic conductivity testing of the overburden, performed during previous investigations, resulted in hydraulic conductivity estimates ranging from 0.2 to 2.3 ft/day, and yields from overburden monitoring wells are typically less than 1 gpm.

3.7.2 Groundwater Flow Directions

The groundwater flow direction in shallow bedrock (to a depth of approximately 100 feet) across Area C is slightly west of due north, with an average gradient of 0.03. The shallow bedrock groundwater flow direction, based on water level measurements taken on May 18 and presented in Table 2-4, is shown in Figure 3-6. The flow direction and gradient closely correlate to the slope of the ground surface, which also trends slightly west of due north and ranges in slope from approximately 0.02 to 0.05. In addition, the groundwater flow direction is subparallel to the bedrock dip direction, and is in the direction of overall surface water drainage towards Neshaminy Creek. This illustrates the interrelationship between shallow groundwater flow directions, topography/drainage, and bedrock structure in this area, as has been seen elsewhere on Base north of the runway (i.e., Area A).

Deeper groundwater flow directions (>120 feet) trend generally to the north-northeast, based on water level measurements from the intermediate depth wells located at well clusters HN-23, HN-26, HN-27, HN-28, and HN-29. The intermediate wells at cluster locations HN-24 and HN-25 are considered to be more representative of the shallow groundwater flow system instead of the deeper flow system tapped by the other intermediate wells, based on lithologic and water level data, thus are not included in the evaluation of deeper groundwater flow directions. Due to the differing lithologic intervals for the intermediate wells, and the variability of hydraulic heads with depth/screened zone, a detailed map of groundwater flow within the deeper bedrock cannot be developed with the existing data.

There is a marked upward vertical gradient between the deeper and more shallow portions of the bedrock aquifer. Hydraulic head differentials of over 15 feet have been measured at several well cluster locations (23, 26, 28 and 29) where shallow and deeper wells have been installed. Some of the deep wells are flowing artesian wells, with hydraulic heads over 10 feet above the top of the well casing. It appears that the confined conditions are created by the presence of a thick, predominantly fine-grained, interbedded mudstone-sandstone unit. Wells installed into the rock units located directly below this unit exhibit the high

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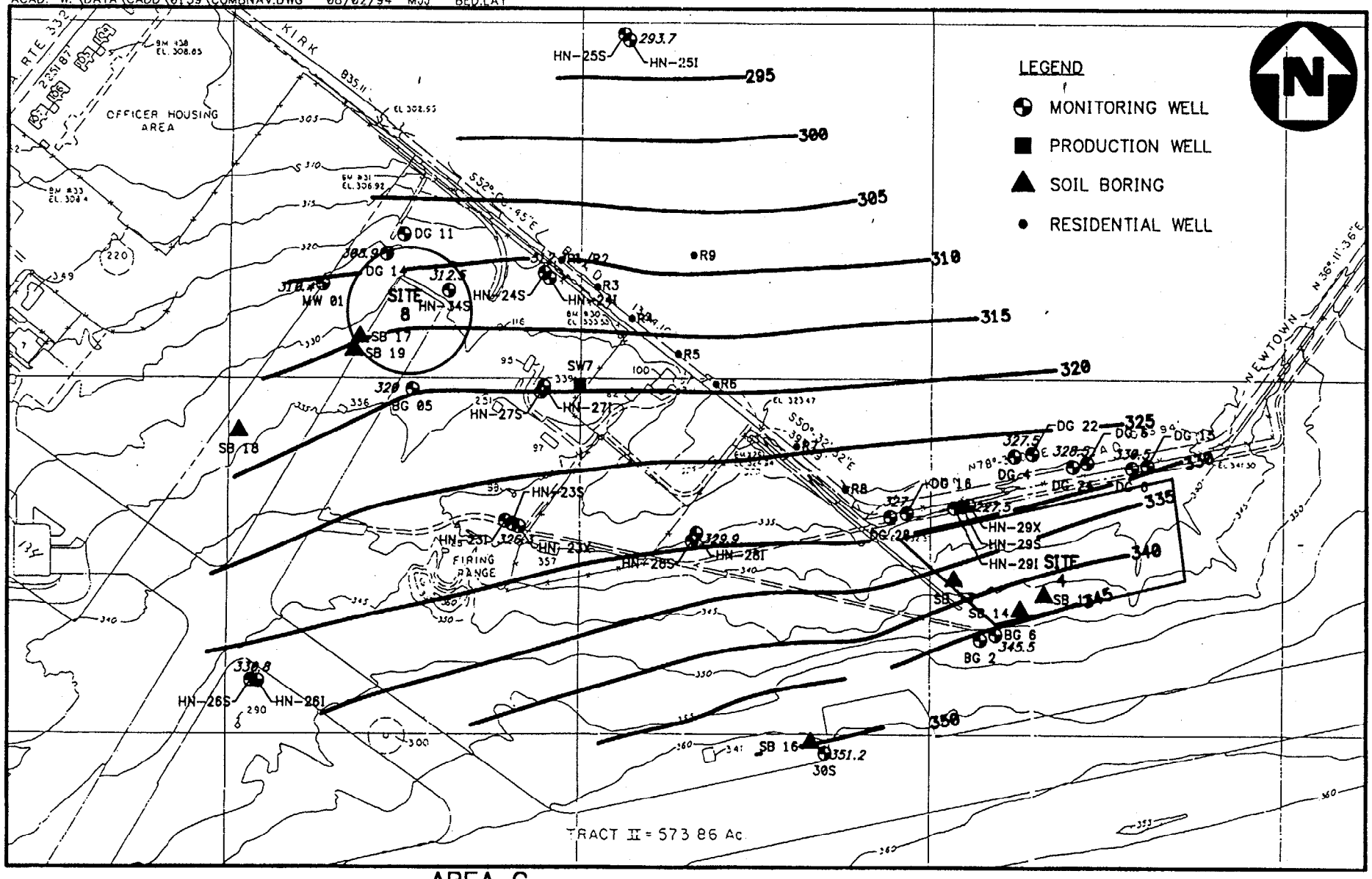

AREA C
SHALLOW BEDROCK
POTENTIOMETRIC SURFACE MAP
5/18/94
NAWC WARMINSTER, PA

0 400 800
SCALE IN FEET

FIGURE 3-6

Halliburton NUS CORPORATION

head differentials in comparison with the adjacent shallow wells. In addition, there is a general trend of higher head differentials within well clusters where the vertical separation between the monitored intervals of the shallow and deep wells is greater (i.e., clusters 24 and 25 have less vertical separation than the other clusters, and also much smaller head differentials).

The local strike and dip measurements were used to project the outcrop/subcrop areas of the rock units that the wells with high hydraulic head differentials are screened in. The units housing the flowing artesian wells are all projected to outcrop along the runway that is located south of Area C and is the topographic high for the area. In addition, the rock units that house the two wells with the highest hydraulic heads are projected to outcrop near the runway in a localized closed topographic depression, which would be an area of enhanced recharge. Precipitation falling in this area would pond within the area and infiltrate, rather than a portion of the precipitation leaving as runoff as would occur elsewhere.

Groundwater flow directions within the overburden are generally to the north following topography, based on a limited data base. This is expected based on the ground surface slope, the bedrock surface slope, and the presence of a small stream north of Area C which is expected to act as a local shallow groundwater discharge point.

Vertical gradients between the overburden and shallow bedrock were mixed. Of the seven overburden/ shallow bedrock well pairs evaluated, downward vertical gradients were noted in 4 clusters and upward gradients in 3. There was no clear pattern to the distribution of vertical gradients. Head differentials were usually less than 1 foot, however differences of up to 6 feet (cluster DG6/DG15) were also observed.

3.7.3 Bedrock Aquifer Hydraulic Characteristics

Field work to quantify the hydraulic characteristics of the bedrock aquifer in Area C was not included in the scope of work for the Area C investigation. Some generalized statements can, however, be made regarding the water yielding capabilities of the shallow portion of the Stockton Formation in the vicinity of Area C, based on drilling/well development observations and limited aquifer testing performed at the facility in the past.

During monitoring well drilling operations, total borehole water yields were estimated by observing the rate at which water was removed from the borehole by air pressure. The estimated total yields of the monitoring well boreholes ranged from 1 to 30 gpm, with an average yield of 12 gpm over an average borehole depth of 125 feet (0.1 gpm/foot of borehole). In general, the primary water-producing zones in the boreholes tended to be associated with sandstone beds, although this was not always the case. Estimated monitoring

well yields, determined during well development operations, ranged from approximately 0.5 to 10 gpm, with an average estimated yield of 3.5 gpm. The wells monitor discrete depth intervals that ranged from 13 to 34 feet in thickness, and averaged about 20 feet in thickness, resulting in an average yield per foot of 0.175 gpm. The depth intervals monitored were selected in part based on their relatively high water yields in comparison to other portions of the boreholes, thus the incremental formation yields for the wells are biased somewhat high over the incremental yields that were observed over the total length of the boreholes.

Two small scale pumping tests have been performed on the shallow portion of the Stockton Formation at NAWC Warminster. Walter B. Satterthwaite Associates, Inc. performed a pumping test in 1984 in the vicinity of the main facility building complex, west of Jacksonville Road. Using wells 100 to 130 feet deep, a transmissivity of 119 ft^2/day and a storativity in the 10^{-4} range were derived for the shallow portion of the aquifer. Halliburton NUS in 1991 performed a small scale test in the northwest corner of the facility, using wells 50 feet in depth and less. The transmissivity derived from this test was 67 ft^2/day, which is generally comparable to the Satterthwaite transmissivity value when the difference in depths of the wells is factored in. The storativity obtained, in the 10^{-4} range, was also in agreement with the Satterthwaite results. A supplemental analysis of the Halliburton NUS pumping test data, performed during the interim groundwater extraction system design for OU-1, resulted in a transmissivity estimate of 104 ft^2/day. Both the Satterthwaite and Halliburton NUS tests were of limited time duration (several hours) so the results obtained should be considered as rough estimates only.

Based on these pumping test results, a bulk permeability for the bedrock aquifer of about 1 to 2 ft/day appears to be a reasonable estimate of the overall shallow bedrock permeability. Since the occurrence and movement of groundwater within the Stockton Formation is largely fracture controlled, actual fracture permeabilities are undoubtedly much higher than the average and the intergranular permeability much lower. Boring log data was evaluated to determine the approximate yields of discrete water-yielding fractures. Almost all of the water-yielding fractures had estimated yields of under 10 gpm, and most fractures had yields of less than 5 gpm. This is comparable to the average estimated yield of the monitoring wells of 3.5 gpm.

3.7.4 Geologic/Hydrogeologic Controls on Contaminant Migration

Migration of contaminants in groundwater within and out from Area C will be influenced by several factors. Groundwater (and contaminant) migration is expected to occur primarily within interconnected networks of fractures within the rock mass. Lateral migration of shallow groundwater is to the north through the shallow bedrock units that underlie Area C, following the groundwater flow gradient and the direction of ground surface slope. Large volume pumping of groundwater from production wells near Area C (i.e.,

WTMA 13) may influence the local groundwater flow pattern somewhat, depending on the location, depth, and pumping rate of the well(s).

The vertical migration of dissolved contaminants within the bedrock aquifer is expected to be limited by the presence of semi-confining units of siltstone/mudstone that are laterally persistent on a local scale, and the presence of significant upward vertical gradients between shallow and deeper zones of preferential flow (primarily sandstone units). In the vicinity of Area C, therefore, any dissolved contamination found within the shallow bedrock is not expected to migrate vertically to deeper geologic/hydrogeologic horizons.

The structural dip of the bedrock in Area C to the north-northwest would influence the migration of any DNAPL present. To date, however, there is no evidence to suggest that DNAPL may be present within Area C.

The unnamed tributary to Little Neshaminy Creek may act as a discharge point for shallow groundwater. The depth to which the stream influences groundwater flow is unknown, but the stream's function as a groundwater discharge point is expected to be minor overall given it's small size and intermittent nature. Deeper groundwater flow may, however, follow the stream valley and thus be indirectly influenced by the stream.

The overburden groundwater is expected to either recharge the bedrock groundwater flow system or discharge to local surface water drainages, thus migration distances within the overburden are likely to be restricted. The low overall permeability and minor saturated thickness of the overburden also suggests that significant quantities of groundwater are not transported laterally through this flow system.

Warminster Township Municipal Well 13 (WTMA 13) is located approximately 1,500 feet due north of Area C, at the intersection of Benn Lane and Vista Drive. This 10-inch-diameter well is 601 feet deep, is cased to a depth of 80 feet, and pumps at an average rate of 85 gallons per minute, with a maximum capacity of 167 gpm. The static water level is 12 feet, and the pumping water level is 155 feet. The average daily withdrawal rate is 68,000 gallons. The intermittent, unnamed tributary of Little Neshaminy Creek is located between Area C and the municipal well. Given the stream's small size and the well's depth and pumping rate, the stream is not expected to act as a buffer between Area C and the municipal landfill. The degree to which the local topography (the ground surface slopes to the north-northwest in the area around the municipal well) may influence or affect the groundwater flow direction in the area between Area C and the municipal well is unknown at this time.

3.8 ECOLOGY AT AREA C

A mixture of residential, park, and forested area borders Area C to the north. This area offers a secluded and physically diverse habitat, as observed during the Phase II RI biological characterization (Halliburton NUS, 1992). Snails, earthworms, and amphipods are common in sediments and leaf packs from downstream portions of Area C as are small numbers of mayfly larvae. In addition to sightings of various songbirds, signs of rabbits, raccoons, and white-tailed deer are also found in the downstream portion of this study area.

A wetlands assessment of the area north of Area C (Halliburton NUS, 1994c) classifies the wetland along the unnamed tributary of Little Neshaminy Creek as primarily palustrine, forested, broad-leaved deciduous, temporary (PF01A). This wetland is characterized by green ash, silver maple, box elder, black cherry, and spicebush in the canopy and sub-canopy. Blackberry, Japanese honeysuckle, jewelweed, poison ivy, and skunk cabbage are the dominant species in the herbaceous layer.

The wetlands assessment concluded that the stream and wetlands appear to be fairly healthy. No evidence of pollution, fish kills, or stressed vegetation was observed. Urban trash and litter (tires, boards, bottles, cans, paper, and plastic) was common.

4.0 NATURE AND EXTENT OF CONTAMINATION

This determination of the nature and extent of contamination at Area C is based on review and interpretation of the analytical data available from the most recent round of groundwater sampling, described in Section 2.0. The results of chemical analyses of the groundwater samples collected at Area C are discussed on a medium-specific basis in this section.

As discussed previously, Area C includes two previously identified areas of potential chemical release. Site 4, located south of the intersection of Kirk and Newtown Roads, has been investigated as a historically active trenching and disposal area. Site 8, located at the north end of the reserve taxiway near Kirk Road, is a former fire training area. Soil borings and groundwater monitoring wells at these sites were sampled during recent field investigation activities. In addition, a maintenance area and firing range (see Figure 1-2) have also been identified as additional potential groundwater contaminant sources within Area C.

Chemical analysis of groundwater collected from Area C was performed at a fixed-base laboratory. Analytical parameters included, at a minimum, low concentrations target compound list (TCL) volatile organic compounds, and total (unfiltered) and dissolved (filtered) target analyte list (TAL) metals. Newly installed monitoring well clusters were also analyzed for TCL semivolatile organic and pesticide/PCB compounds. All data were generated using U.S. EPA Contract Laboratory Program (CLP) analytical methods and reporting protocol.

All reported results were subjected to a data validation which was conducted in accordance with the functional guidelines established by the U.S. EPA and modified by U.S. EPA Region III. Although no significant analytical problems were encountered, nondetected acetone and 2-butanone data in some samples were rejected due to poor detector response for these chemicals. The rejection of these data points does not significantly affect the conclusions that are made with regard to nature and extent of contamination, or the baseline risk assessment.

4.1 SOILS

Soils were not sampled as a part of the most recent field investigation. The soils sampled during the Phase II RI field investigation at Area C (Halliburton NUS, 1992) were analyzed by gas chromatography for determination of volatile organic compounds in the field. The samples were subsequently analyzed at a fixed-base analytical laboratory for determination of TCL volatile and semivolatile organic and pesticide/PCB

compounds, in addition to TAL metals and cyanide. Total petroleum hydrocarbons (TPH) and several miscellaneous engineering parameters were also determined for the soil samples collected from Area C.

Site 4 subsurface soil and sediment were found to contain detectable concentrations of acetone (48 μg/kg), tetrachloroethene (7.75 μg/kg), ethylbenzene (56 μg/kg), and xylenes (130 μg/kg). These positive detections were noted in two soil samples (tetrachloroethene in one, ethylbenzene and xylenes in the other) and one sediment (acetone only). No widespread or clear pattern of organic detection in soils or sediment which may be considered identification of a contaminant source area was identified, although it should be noted that the sampling was limited in scope. Numerous metallic elements were detected in the Site 4 soils; however, no clear pattern was identified. Metals concentrations which exceed established background levels include: aluminum (18,500 mg/kg maximum), barium (157 mg/kg maximum), cadmium (7.8 mg/kg maximum), cobalt (16.7 mg/kg maximum), nickel (38.8 mg/kg maximum), vanadium (59 mg/kg), and zinc (55.3 mg/kg, maximum). Tentatively identified compounds (TICs) were not reported for Phase II soil sampling.

Soil samples collected from Site 8 were also found to have low concentrations of a variety of polynuclear aromatic hydrocarbons (PAHs), one detection of gamma-chlordane (a pesticide), and tentatively identified compounds. Also, several metals were detected at concentrations which exceed background levels in surface and subsurface soil. Although detected at levels slightly greater than the "background," metals are not believed to be a site related contaminant because of the type of activity performed at the site (fire training) and because samples were collected at visibly contaminated areas and few metals exceeded more than twice background.

Detailed discussions of the soil and sediment sampling conducted during the Phase II RI is presented in the Phase II RI Report (Halliburton NUS, 1992).

4.2 GROUNDWATER

A total of 30 groundwater monitoring wells were sampled during the field investigation. These monitoring wells have generally been installed in groups, or clusters, in an attempt to characterize the vertical extent of the observed contaminant plumes. The well clusters, totalling 12 in number, are screened within the bedrock at shallow and intermediate depths, or within the overburden and shallow bedrock. Four individual shallow wells are located around the former fire training area, Site 8. Four well clusters (HN-23, HN-24, HN-26, and HN-27) are located generally within the western half of Area C. One well cluster, HN-28S and HN-28I, is located about midway between Sites 4 and 8. Well cluster HN-25 is located approximately 700 feet north (downgradient) of Area C. The remaining wells surround Site 4 on the north (DG-4, DG-5,

DG-6, DG-15, DG-16, DG-22, DG-24, DG-28, HN-29S, and HN-29I) and south (BG-2 and BG-6), in the eastern half of Area C.

The results of all monitoring well sampling conducted during the focused RI are presented in Table 4-1.

Background wells are identified as the upgradient wells in Area C (BG-2, BG-6, HN-26I, and HN-26S) and Area B (HN-01I and HN-01D), which is located across the runway (south) of Area C. Table 4-2 provides a listing of the wells sampled, broken out into groupings (background, Area C overall, Site 4).

Confining features which resulted in the installation of naturally flowing "artesian" wells are noted for the intermediate screening interval at well clusters HN-23, HN-26, HN-28, and HN-29. A mudstone-siltstone layer appears to create the confining pressure and may act as a significant retardant to vertical groundwater contaminant migration. Groundwater is primarily transmitted through fractures within the bedrock. Although uncertainties inherent in fracture flow regimes complicates microscopic prediction of plume movement, the number and location of wells at Area C allows general assessment of groundwater movement. As shown in Figure 3-6, the shallow groundwater potentiometric surface indicates groundwater flow to be generally toward the north. Local variations in the groundwater flow direction are influenced by fracturing in the bedrock, and results for individual wells must be considered carefully to avoid reaching misleading conclusions about contaminant migration.

4.2.1 Site 8 and Adjacent Areas

Four functional monitoring wells of varying depth (MW-01, DG-14, HN-34S, and BG-05) are located in the immediate vicinity of Site 8.

Organic contaminants were detected only in wells HN-34S and MW-01. In particular, tetrachloroethene (PCE) was detected at levels of 9 μg/L and 1 μg/L, respectively, in these wells. In addition, di-n-butylphthalate was detected at 1 μg/L in HN-34S.

Four well clusters (HN-23S, HN-23I, and HN-23X; HN-24S and HN-24I; HN-25S and HN25-I; and HN-27S and HN-27I) are located in an approximate north-south oriented line located about 300 feet to the east of Site 8, downgradient of the small maintenance area and firing range. For these wells, the predominant chemical detected is tetrachloroethene, found in six wells at concentrations which range from 2 μg/L (HN-23X, HN-25I) to 29 μg/L (HN-24S). Tetrachloroethene detection is associated with acetone in wells HN-23S, HN-24S, and HN-24I and with di-n-butylphthalate in wells HN-25S and HN-34S. Diethylphthalate

TABLE 4-1

DATA SUMMARY TABLE
POSITIVELY DETECTED CHEMICALS (μg/L) - AREA C MONITORING WELLS
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Area "C" Monitoring Wells													
	BG-2		BG-5		BG-6		MW-01		MW-02		DG-4		DG-5	
Acetone	R		R		R		R		R		R		R	
Toluene	ND (1)		ND (1)		ND (1)		ND (1)		ND (1)		ND (1)		ND (1)	
Tetrachloroethene	ND (1)		1.0		ND (1)		1.0		2.0		ND (1)		ND (1)	
Diethylphthalate	NA		NA		NA		NA		NA		NA		NA	
Di-n-butyl phthalate	NA		NA		NA		NA		NA		NA		NA	
Endosulfan II	NA		NA		NA		NA		NA		NA		NA	
Aluminum	ND (33)	372	121	44.2B	7370	ND (33)	668	ND (33)	481	ND (33)	366	ND (33)	999	ND (33)
Antimony	ND (34)	ND (34)	ND (34)	59.5J	ND (34)	37.0L	ND (34)	ND (34)	ND (34)	ND (34)	ND (34)	35.2L	ND (34)	ND (34)
Arsenic	ND (3)	ND (3)	ND (3)	ND (3)	5.9	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	3.2	ND (3)	3.2	ND (3)
Barium	40.8J	47.8	154	122	114J	45.7	211	175	213	165	593J	552	182J	92.9
Beryllium	ND (1)	ND (1)	ND (1)	ND (1)	1.5	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Cadmium	ND (3)	ND (3)	ND (3)	ND (3)	3.8K	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	3.3K	4.3J	ND (3)	ND (3)
Calcium	11,900J	11,500J	15,000	13,800	15,200J	9070J	20,100	20,000	19,900	19,700	27,000J	28,300J	60,100J	56,400J
Chromium	ND (7)	ND (7)	12B	ND (7)	ND (7)	ND (7)	10.6B	10.0B	14.7B	7.5B	ND (7)	ND (7)	8.0K	ND (7)
Cobalt	ND (4)	ND (4)	ND (4)	ND (4)	4.1	ND (4)	6.1B	ND (4)	ND (4)	ND (4)	ND (4)	4.1B	ND (4)	ND (4)
Copper	7.8	7.1K	8.5	ND (6)	10.1	ND (6)	6.6	6.1	6.8	ND (6)	7.7	ND (6)	14.4	ND (6)
Iron	5650J	13,700	107	18.4B	3130J	ND (5)	1040	14.8B	864	15.9B	35,200J	18,200	12,500J	1620
Lead	ND (1)	1.7J	ND (1)	ND (1)	11.9	ND (1)	ND (1)	ND (1)	ND (1)	15.9	3.2	ND (1)	3.2	ND (1)
Magnesium	5130J	5020J	4710	4330	5450J	2790J	5240	4970	5040	4990	6820J	7150J	12,000J	11,200J
Manganese	451	462	66.2	6B	89.9	27.4	140	2.8B	131	4.3B	1030	1060	1180	1080
Mercury	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	0.17	0.33	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	(0.13)	ND (0.13)	ND (0.13)	ND (0.13)
Potassium	2360J	2220	924	1010	1350J	964	915	888B	797B	834B	1330J	1370	1180J	1160
Sodium	6370J	6380	6530	6040	12,700J	13,700	7650	7240	7310	7300	10,800J	11,300	14,000J	13,000
Thallium	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)
Vanadium	ND (3)	3.6	ND (3)	ND (3)	4.5B	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	5.2B	ND (3)	5.2B	ND (3)
Zinc	10.3B	26.8	9.8	6.1	38.4B	11.7	8.4	6.5	9.0	5.6	51B	7.6L	19.9B	ND (3)

TABLE 4-1 (Continued)
DATA SUMMARY TABLE
POSITIVELY DETECTED CHEMICALS (μg/L) - AREA C MONITORING WELLS
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Area "C" Monitoring Wells											
	DG-6		DG-14		DG-15		DG-16		DG-22		DG-24	
Acetone	17		7B		R		62L		R		R	
Tetrachloroethene	ND (1)		ND (1)		ND (1)		ND (1)		ND (1)		ND (1)	
Diethylphthalate	NA		NA		NA		ND (10 UL)		NA		NA	
Di-n-butyl phthalate	NA		NA		NA		ND (10 UL)		NA		NA	
Endosulfan II	NA		NA		NA		ND (0.10)		NA		NA	
Aluminum	639	ND (33)	ND (33)	ND (33)	169	ND (33)	383	ND (33)	79.2	ND (33)	171	ND (33)
Antimony	ND (34)	ND (34)	ND (34)	39.0J	ND (34)	ND (34)	ND (34)	ND (34)	ND (34)	45.9L	ND (34)	50.9L
Arsenic	ND (3)	ND (3)	ND (3)	ND (3)	3.1	ND (3)	4.4	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)
Barium	250J	243	101	92.1	329J	301	442J	462	381J	371K	244J	232
Beryllium	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Cadmium	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	3.2K	ND (3)	ND (3)	ND (3)
Calcium	56,300J	58,600J	17,200	16,900	67,700J	64,000J	51,700J	53,000J	50,700J	49,400J	64,900J	63,500J
Chromium	ND (7)	ND (7)	12.6B	9.7B	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)
Cobalt	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	4.1B	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)
Copper	7.0	ND (6)	7.3	ND (6)	ND (6)	ND (6)	ND (6)	ND (6)	ND (6)	ND (6)	ND (6)	ND (6)
Iron	17,300J	11,500	45.7B	15.6B	172B	17.7	590J	ND (5)	125B	ND (5)	204J	ND (5)
Lead	3.5	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Magnesium	8980J	9330J	4980	4850	10,900J	10,300J	16,800J	17,200J	12,200J	12,000J	9500J	9390J
Manganese	547	653	2.6B	2.4B	1720	1380	20.2	3.5K	106	27.6K	165	61.5
Mercury	0.15	ND (0.13)	ND (0.13)	ND (0.14)	ND (0.14)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.14)	ND (0.14)
Potassium	1230J	1170	761B	761B	1220J	1030	1760J	1620	1590J	1510	971J	865
Sodium	10,200J	10,700	8560	8310	12,100J	11,400	10,500J	10,900	10,300J	10,300	11,300J	11,300
Thallium	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)
Vanadium	5.4B	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)
Zinc	225J	47.0	25.0	6.1	21.2B	8.5L	10.8B	9.3L	17.4B	ND (3)	16.8B	ND (3)

TABLE 4-1 (Continued)
DATA SUMMARY TABLE
POSITIVELY DETECTED CHEMICALS (μg/L) - AREA C MONITORING WELLS
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Area "C" Monitoring Wells													
	DG-28		HN23-S		HN23-I		HN23-X		HN24-S		HN24-I		HN24-X	
Acetone	R		74		ND (5)		10		34		R		15	
Tetrachloroethene	ND (1)		3.0		ND (1)		2.0		29		16		16	
Diethylphthalate	ND (10)		ND (10)		ND (10)		ND (10)		ND (10)		ND (10)		1J	
Di-n-butyl phthalate	ND (10)		ND (10)		ND (10)		ND (10)		ND (10)		ND (10)		ND (10)	
Endosulfan II	ND (0.10)		ND (0.10)		ND (0.10)		ND (0.10 UL)		ND (0.10 UL)		ND (0.10)		ND (0.10 UL)	
Aluminum	453	ND (33)	171	ND (33)	104	ND (33)	11,600	ND (33)	138	ND (33)	ND (33)	363	393	ND (33)
Antimony	ND (34)	53.6L	ND (34)	37.0L	ND (34)	ND (34)	ND (34)	ND (34)	ND (34)	ND (34)	ND (34)	ND (34)	ND (34)	ND (34)
Arsenic	ND (3)	ND (3)	ND (3)	ND (3)	3.2	ND (3)	3.5	ND (3)	4.1	ND (3)	5.2	5.4L	7.1	5.4L
Barium	76.3J	80.1	276J	204	235J	231	219J	56.1	292J	213	181J	272	243J	172
Beryllium	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	1.1	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Cadmium	3.2K	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	3.8K	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	3.4K	ND (3)
Calcium	30,100J	33,700J	28,300J	26,700J	25,300J	25,000J	38,600J	35,900J	48,400J	46,300J	35,400J	35,100J	36,400J	35,000J
Chromium	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)	13.4K	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)
Cobalt	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	16.5	13.6B	ND (4)	4.1B	ND (4)	ND (4)	ND (4)	ND (4)
Copper	9.6	8.3	13.4	ND (6)	ND (6)	ND (6)	16.0	6.2K	ND (6)	ND (6)	ND (6)	6.5K	7.1	6.5K
Iron	572J	ND (5)	155B	ND (5)	78.8B	9.1	12,500J	5.6	105B	ND (5)	49.8B	557	513J	ND (5)
Lead	ND (1)	ND (1)	1.3	ND (1)	ND (1)	ND (1)	6.0	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	1.0	ND (1)
Magnesium	10,600J	11,900J	7620J	7220J	15,600J	15,600J	19,900J	15,800J	17,900J	17,300J	12,100J	12,000J	12,400J	12,000J
Manganese	81	1.4	13.6	1.6	4.4B	ND (1)	651	446	22.4	20.2K	16.2	25.7	26.6	13.5
Mercury	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
Potassium	877J	875	952J	747	1160J	1000	1420J	757	1010J	885	1060J	1040	1120J	944
Sodium	6690J	7350	8350J	8210	8260J	8510	12,700J	11,900	13,300J	12,800	34,200J	34,600	35,200J	33,700
Thallium	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)
Vanadium	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	20.9	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	3.3B	ND (3)
Zinc	7.5B	5.8	21.6B	5.1	30.2B	ND (3)	56.9B	26.9	13.1B	3.5L	9.1B	28.1	27.6B	4.6

TABLE 4-1 (Continued)
DATA SUMMARY TABLE
POSITIVELY DETECTED CHEMICALS (μg/L) - AREA C MONITORING WELLS
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Area "C" Monitoring Wells													
	HN25-S		HN25-I		HN26-S		HN26-I		HN27-S		HN27-I		HN28-S	
Acetone	ND (5)		ND (5)		R		R		5B		R		8.0	
Tetrachloroethene	ND (1)		2.0		ND (1)		ND (1)		ND (1)		ND (1)		ND (1)	
Diethylphthalate	ND (10)		ND (10)		ND (10)		ND (10)		ND (10)		ND (10 UL)		ND (10)	
Di-n-butyl phthalate	2J		2J		ND (10)		ND (10)		ND (10)		1J		1J	
Endosulfan II	NA		NA		ND (0.10 UL)		ND (0.10 UL)		ND (0.10 UL)		ND (0.10 UL)		0.24J	
Aluminum	6920	ND (33)	677	ND (33)	2100	ND (33)	131	ND (33)	83.9	ND (33)	189	ND (33)	2340	48.5B
Antimony	ND (34)	ND (34)	ND (34)	56.0L	57.5B	ND (34)	ND (34)	64.7J	50.0B	62.0J	ND (34)	ND (34)	ND (34)	ND (34)
Arsenic	5.0	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	4.3B	ND (3)	ND (3)	ND (3)	ND (3)	13.6	10.9L
Barium	554J	28.4	234J	158	223	122	176	167	154	59.6	376	349	198J	132
Beryllium	1.5	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Cadmium	4.4K	5.5K	4.3K	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)
Calcium	35,900J	30,200J	38,700J	35,200J	18,500	18,900	21,200	22,300	16,600	16,700	31,800	31,800	23,200J	22,100J
Chromium	14.0K	ND (7)	ND (7)	ND (7)	7.5B	ND (7)	ND (7)	8.7B	13.2B	8.3B	ND (7)	9.3B	ND (7)	ND (7)
Cobalt	ND (4)	ND (4)	ND (4)	4.1B	ND (4)	5.3B	4.2B	6.1B	5.0B	ND (4)	ND (4)	5.0B	ND (4)	ND (4)
Copper	13.1	7.2K	19.8	7.7K	10.4	ND (6)	ND (6)	8.0	7.7	ND (6)	ND (6)	7.7	ND (6)	ND (6)
Iron	3150J	ND (5)	1090J	ND (5)	1770	11.0B	79.4B	17.9B	68.8B	27.7B	238	23.2B	1440J	44.0
Lead	10.9	ND (1)	6.7	ND (1)	1.7L	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	3.1	ND (1)
Magnesium	6820J	5260J	9980J	9110J	6980	6850	12,700	13,200	7270	7290	13,300	13,100	10,200J	9520J
Manganese	354	60.3	235	183	266	57.6	6.2B	5.6B	14.7	11.5	85.2	68.1	46.0	18.4
Mercury	0.22	ND (0.13)	0.20	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
Potassium	1380J	954	1350J	1000	1150	1190	1130	1240	1680	1730	1620	1580	1940J	1730
Sodium	25,900J	26,400	11,700J	10,700	8330	8900	11,500	11,900	12,100	12,100	10,700	10,600	24,000J	24,700
Thallium	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)
Vanadium	4.5B	ND (3)	ND (3)	ND (3)	3.1	ND (3)	ND (3)	3.8	ND (3)	ND (3)	ND (3)	ND (3)	4.8B	ND (3)
Zinc	58.5B	18.9	39.1B	21.1	14.1	7.2	16.2	ND (3)	11.4	10.5	29.2	15.4	24.5B	4.8

TABLE 4-1 (Continued)
DATA SUMMARY TABLE
POSITIVELY DETECTED CHEMICALS (μg/L) - AREA C MONITORING WELLS
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Area "C" Monitoring Wells													
	HN28-I		HN28-X		HN29-S		HN29-I		HN29-X		HN34-S		HN34-X	
Acetone	14		10L		10L		R		15L		R		R	
Toluene	ND (1)		ND (1)		ND (1)		ND (1)		ND (1)		ND (1)		ND (1)	
Tetrachloroethene	ND (1)		ND (1)		ND (1)		ND (1)		ND (1)		9.0		ND (1)	
Diethylphthalate	ND (10)		ND (10)		ND (10)		ND (10)		ND (10)		ND (10)		ND (10)	
Di-n-butyl phthalate	ND (10)		ND (10)		ND (10)		ND (10)		ND (10)		1J		ND (10)	
Endosulfan II	ND (0.10)		ND (0.10)		ND (0.10 UL)		ND (0.10)		ND (0.10 UL)		ND (0.10 UL)		ND (0.10)	
Aluminum	60.2	ND (33)	45.9	ND (33)	225	ND (33)	ND (33)	ND (33)	20,900	ND (33)	200	ND (33)	99.5	ND (33)
Antimony	ND (34)	ND (34)	47.3L	ND (34)	ND (34)	ND (34)	ND (34)	ND (34)	ND (34)	36.7L	ND (34)	45.8J	ND (34)	ND (34)
Arsenic	3.9	ND (3)	ND (3)	ND (3)	3.0K	ND (3)	3.5K	ND (3)	6.6K	ND (3)	ND (3)	ND (3)	5.4K	3.7K
Barium	351J	282	380	306	216	141	342	317	253	107	179	125	265	242
Beryllium	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	1.1	ND (1)	ND (1)	ND (1)	ND (1.0)	ND (1)
Cadmium	ND (3)	ND (3)	ND (3)	ND (1)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)
Calcium	35,600J	33,000J	33,800	31,900	54,500	51,100	33,500	32,800	43,500	41,900	39,900	35,000	27,800	28,600
Chromium	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)	ND (7)	15.5	ND (7)	ND (7)	11B	ND (7)	ND (7)
Cobalt	ND (4)	4.1B	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	18.6B	ND (4)	5B	4.2B	4.1B	ND (4)
Copper	ND (6)	ND (6)	ND (6)	ND (6)	7.7K	ND (6)	ND (6)	ND (6)	79.2	6.3	25.8	17.3	7.6K	ND (6)
Iron	576J	263	293	183	206B	ND (5)	276	175	15,400	26.8	337	26B	120B	ND (5)
Lead	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	6.1B	ND (1)	2.7L	ND (1)	2.1B	ND (1)
Magnesium	12,900J	12,100J	13,600	12,800	15,200	14,200	13,500	13,200	33,700	28,000	14,100	12,300	7570	7810
Manganese	719	653	578	545	67.6	28.1	575	563	1840	12.3	25.1	9.4	13.5	4.4
Mercury	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.14)	ND (0.14)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
Potassium	1070J	914	836	806	2000	1910	796	885	2040	1360	1200	1110	865	855
Sodium	9810J	9470	10,600	9810	22,400	21,200	10,400	10,300	17,400	15,200	10,600	9360	8660	8680
Thallium	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	5.1	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)	ND (4)
Vanadium	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)	21.7	ND (3)	ND (3)	ND (3)	ND (3)	ND (3)
Zinc	23.6B	ND (3)	ND (3)	ND (3)	71.3	44.4B	ND (3)	ND (3)	47.8	15.4B	48.8	8.5	46.2	7.8B

Metals results for unfiltered samples are presented in left hand column and for filtered samples are presented in right hand column for each sample.

Qualifier Codes: ND = analyte not detected at quantitation/detection limit in parenthesis, J = estimated result, B = not detected due to blank contamination, K = positive result biased high, L = positive result biased low, UJ = estimated quantitation limit, UL = estimated quantitation limit, biased low.

TABLE 4-2

MONITORING WELL GROUPINGS
NAWC WARMINSTER, PENNSYLVANIA

Background Wells	Area C Wells		Site 4 Downgradient Wells
BG-2	BG-5	HN-23I	DG-4
BG-6	MW-01[1]	HN-23X	DG-5
HN-01I	MW-02[1]	HN-24S	DG-6
HN-01D	DG-4	HN-24I[3]	DG-15
HN-26S	DG-5	HN-24X[3]	DG-16
HN-26I	DG-6	HN-25S	DG-22
	DG-14	HN-25I	DG-24
	DG-15	HN-26S	DG-28
	DG-16	HN-26I	HN-28X[4]
	DG-22	HN-27S	HN-29S[4]
	DG-24	HN-27I	HN-29I
	DG-28	HN-28I	HN-29X
	HN-23S[2]	HN-28X[4]	
		HN-29S[4]	
		HN-29I	
		HN-29X	
		HN-34S	
		HN-34X[2]	

(1) Field duplicate sample pair
(2) Field duplicate sample pair
(3) Field duplicate sample pair
(4) Field duplicate sample pair

Note: Well identification numbers correspond to Table 4-1 sample identification numbers.

is also detected in HN-24I at 1 μg/L, but its presence was not confirmed in the duplicate of this sample. The upgradient well cluster, HN-26S and HN-26I, as well as HN-23I, HN-23X, HN-27S, and HN-27I, did not contain detectable quantities of any organic chemicals.

The distribution of PCE across Area C is shown in Figure 4-1.

Numerous metals were detected in the unfiltered and filtered groundwater samples collected from Site 8 wells; however, the concentrations appear to be generally within background ranges. Total metals results will be used to support conclusions about groundwater chemicals at Area C. The total metals concentrations, although to be used for risk assessment purposes, can provide misleading information because of suspended materials in the sample. Dissolved metal results can sometimes provide a more accurate of the presence or absence of mobile metals in groundwater.

4.2.2 Site 4 and Adjacent Areas

Site 4 has been identified as a landfill area where trenches were dug and materials deposited prior to backfilling. It is alleged that hazardous materials may have been disposed of in the trenches. Groundwater immediately adjacent to and upgradient of the site (BG-2 and BG-6) do not contain detectable quantities of organic chemicals. On the downgradient (north) side of the site, low concentrations of acetone and toluene were detected. Acetone was detected at concentrations of 52 μg/L and 17 μg/L in wells DG-16 and DG-6, respectively. Acetone is also present at concentrations ranging from 10 to 15 μg/L in the cluster of shallow, intermediate, and deep wells at HN-29. The positive acetone result in the intermediate well was not confirmed in the associated field duplicate sample, which was nondetect for this and all other organic compounds. Toluene is present at DG-22 and DG-24 at concentrations of 1 and 2 μg/L, respectively. No other positive results are reported for organic chemicals in the wells around Site 4.

Monitoring wells HN-28S and HN-28I, located about 600 feet west of Site 4 and 1,000 feet east of Site 8 contained several organic compounds at low concentrations. HN-28S contains detectable amounts of acetone (8 μg/L), di-n-butylphthalate (1 μg/L) and the pesticide endosulfan II (0.37 μg/L). The intermediate depth well contained acetone at a concentration of 4 μg/L. The pesticide detection is surprising in that this chemical has not been historically detected in Area C and it is not typically detected in the groundwater because of a high affinity for binding to organic carbon contained in soil. It is worthy to note that detected concentration is low (very near the analytical detection limit). Cluster 28 is not located downgradient of any identified potential source areas, so the low concentration positive detections of organics is unexpected.

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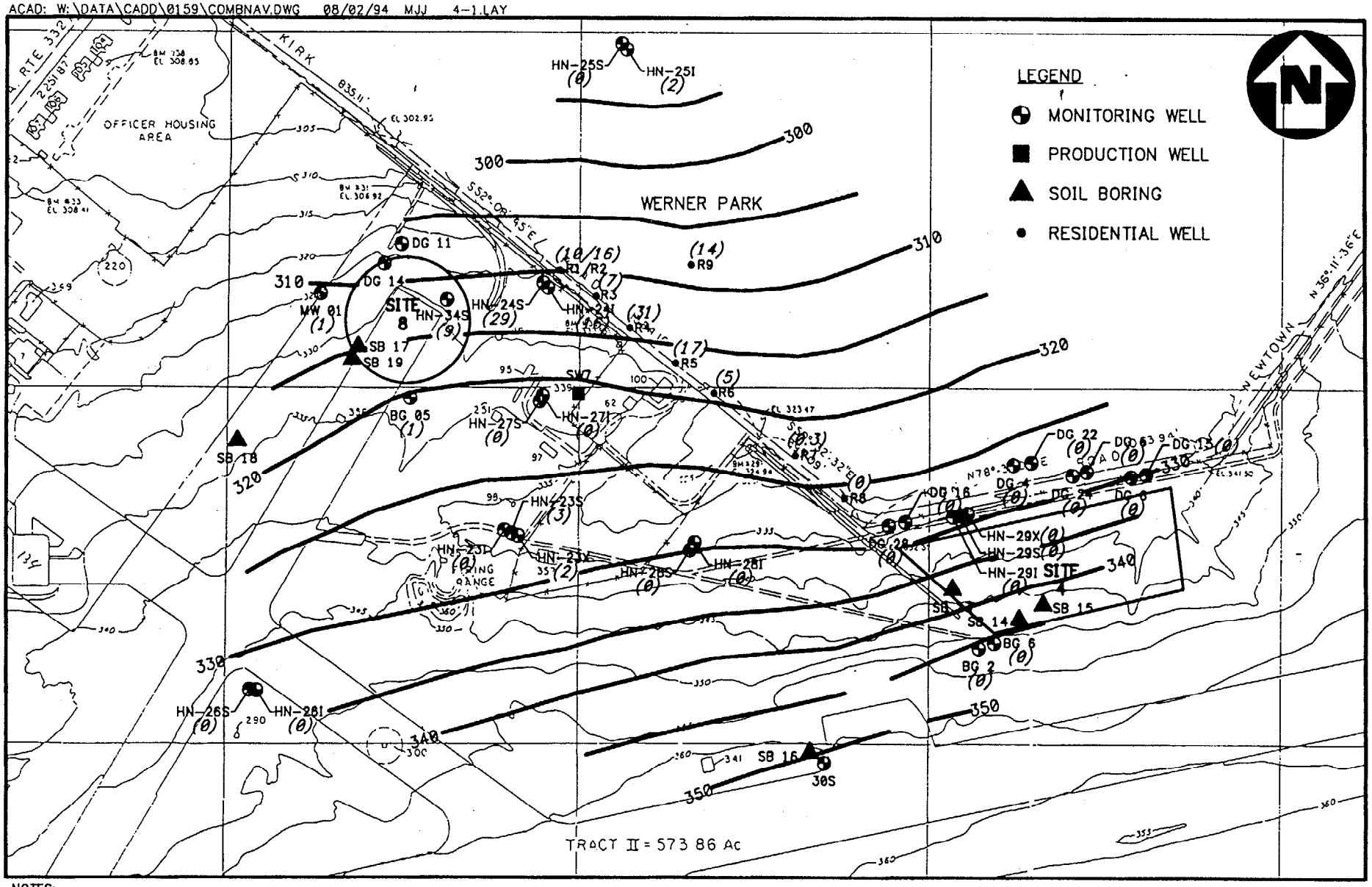

NOTES:

1. POTENTIOMETRIC SURFACE IS REPORTED IN FEET ABOVE MEAN SEA LEVEL
2. PCE CONCENTRATIONS ARE REPORTED IN µG/L.
3. R1 THROUGH R8 ARE RESIDENTIAL WELLS ALONG ALONG KIRK ROAD. R9 IS A SUPPLY WELL FOR WERNER PARK.

AREA C
SHALLOW GROUNDWATER
PCE CONCENTRATIONS
NAWC WARMINSTER, PA

0 400 800
SCALE IN FEET

FIGURE 4-1

Halliburton NUS CORPORATION

Numerous metals were detected in unfiltered and filtered groundwater samples collected from Site 4 wells; however, with the exception of a single detection of thallium, the representative concentrations appear to be within background ranges.

A summary of the analytical results reported for positively detected chemicals in the filtered and unfiltered groundwater samples is provided in Table 4-1. Also, a summary of the range of detections and frequency of positive detection for chemicals detected in at least one sample from Area C is provided in Table 4-3. The information in the frequency of detection table allows the identification of the location where the maximum concentration was detected. Appendix E contains the complete set of analytical results.

4.3 OFF-BASE RESIDENTIAL WELLS

A number of off-Base wells in the vicinity of Area C have been sampled by the Navy since the Spring of 1993. These wells include all homes located on Kirk Road as well as a well serving Werner Park (see Figure 4-1). The samples were analyzed for volatile organic compounds, the results of which indicate the presence of tetrachloroethene in seven wells at concentrations which range from 5 to 31 μg/L. As shown in Figure 4-1, the tetrachloroethene groundwater contaminant plume appears to be centered around several residences that parallel Kirk Road. The affected locations have subsequently been provided water treatment systems by the Navy and/or are being connected to a public water supply.

TABLE 4-3

FREQUENCY OF OCCURRENCE AND DISTRIBUTION POSITIVELY DETECTED CHEMICALS - AREA C MONITORING WELLS NAWC WARMINSTER, PENNSYLVANIA

Chemical	Frequency of Detection	Range of Positive Results (μg/L)	Location of Maximum
ORGANICS			
Acetone	9/24	8-74	HN23-S
Toluene	2/34	1-2	DG-22
Tetrachloroethene	10/34	1-29	HN24-S
Diethylphthalate	1/22	1	HN24-I
Di-n-butyl phthalate	4/22	1-2	HN25-S,I
Endosulfan II	1/22	0.24	HN28-S
TOTAL METALS			
Aluminum	30/34	45.9-20,900	HN29-X
Antimony	1/34	47.3	HN29-I
Arsenic	17/34	3.0-13.6	HN28-S
Barium	34/34	40.8-593	DG-4
Beryllium	4/34	1.1-1.5	BG-6/HN25-S
Cadmium	8/34	3.2-4.4	HN25-S
Calcium	34/34	11,900-67,700	DG-15
Chromium	4/34	8.0-15.5	HN29-X
Cobalt	2/34	4.1-16.5	HN23-X
Copper	21/34	6.6-79.2	HN29-X
Iron	23/34	107-35,200	DG-4
Lead	12/34	1.0-11.9	BG-6
Magnesium	34/34	4,710-33,700	HN29-X
Manganese	31/34	13.5-1,840	HN29-X
Mercury	5/34	0.13-0.22	HN25-S
Potassium	32/34	865-2,360	BG-2
Sodium	34/34	5,370-35,200	HN24-I
Thallium	1/34	5.1	HN29-I
Vanadium	2/34	20.9-21.7	HN29-X
Zinc	13/34	8.4-225	DG-6

TABLE 4-3 (Continued)
FREQUENCY OF OCCURRENCE AND DISTRIBUTION
POSITIVELY DETECTED CHEMICALS - AREA C MONITORING WELLS
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Frequency of Detection	Range of Positive Results (μg/L)	Location of Maximum
DISSOLVED METALS			
Aluminum	1/34	372	BG-2
Antimony	12/34	35.2-64.7	HN26-I
Arsenic	4/34	3.7-10.9	HN28-S
Barium	34/34	45.7-552	DG-4
Cadmium	2/34	4.3-5.5	HN25-S
Calcium	34/34	9,070-64,000	DG-15
Copper	11/34	6.1-17.3	HN34-S
Iron	13/34	5.6-18,200	DG-4
Lead	2/34	1.7-15.9	MW01
Magnesium	34/34	2,790-28,000	HN29-X
Manganese	28/34	1.4-1,380	DG-15
Mercury	1/34	0.33	BG-6
Potassium	31/34	747-2,220	BG-2
Sodium	34/34	5,380-34,600	HN24-I
Vanadium	2/34	3.6-3.8	HN26-I
Zinc	23/34	3.5-47.0	DG-6

5.0 CONTAMINANT FATE AND TRANSPORT

The ultimate fate of chemicals in the environment is determined by a multitude of physical, chemical, and biologically related factors. The role that physical properties such as specific gravity, solubility, and vapor pressure play in determining what processes take place for a particular chemical is often variable, and can vary considerably from location to location, even within the same contaminant regime. Chemical and biological transformational processes can also be significantly affected by localized effects.

This section of the report will provide a summary of the physical and chemical transport properties for the chemicals detected in the groundwater at Area C. No distinction of location or magnitude of chemicals will be made in this section. The information presented in the second subsection will discuss chemical persistence and transport phenomena for the general classes of compounds detected in the groundwater. Finally, the last section will address contaminant migration routes and qualitatively identify the routes of human exposure.

5.1 PHYSICAL AND CHEMICAL PROPERTIES

Various chemical and physical properties of the detected contaminants are presented and discussed in this section. These parameters are used to estimate the environmental behavior of site chemicals. Empirically determined literature values of the water specific gravity, vapor pressure, solubility, octanol/water partition coefficient, organic carbon partition coefficient, soil-water partitioning coefficient, and Henry's Law constant are presented. Calculated values are presented if literature values are not available. A discussion of the environmental significance of each of these parameters follows.

A summary of the physical and chemical transport properties for positively detected organic chemicals is provided in Table 5-1. Partitioning coefficient ranges for detected metals are presented in Table 5-2. This data is used to evaluate contaminant migration and assess exposures in the risk assessment.

5.1.1 Specific Gravity

Specific gravity is the ratio of the weight of a given volume of pure chemical at a specified temperature to the weight of the same volume of water at a given temperature. Its primary use is to determine whether a contaminant will have a tendency to float or sink in water if it is present as a pure compound or at very high

TABLE 5-1

ENVIRONMENTAL FATE AND TRANSPORT DATA
FOR POSITIVELY DETECTED ORGANIC COMPOUNDS - AREA C GROUNDWATER
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Molecular Weight (gm/mol)	Specific Gravity	Vapor Pressure (mm Hg)	Solubility (mg/L)	Octanol-Water Partitioning Coefficient (Kow)	Organic Carbon Partitioning Coefficient (Koc)	Henry's Law Constant (atm m^3/mol)
Acetone	58.08	0.7899	266	Miscible	0.575	9.2	4.28×10^{-5}
Toluene	92.14	0.8669	28	515	490	300	5.92×10^{-3}
Tetrachloroethene	165.83	1.623	19	150	339	364	2.69×10^{-2}
Diethylphthalate	222.24	1.118	0.05 (70 °C)	1,080	912	142	8.46×10^{-7}
Di-n-butylphthalate	278.35	1.047	0.1 (115 °C)	400	1.59×10^{5}	1.7×10^{5}	2.8×10^{-7}
Endosulfan II	406.95	1.745	1×10^{-5}	0.33	4.26×10^{3}	9.6×10^{-3}	1.91×10^{-5}

TABLE 5-2

SUMMARY OF SOIL PARTITIONING VALUES FOR POSITIVELY DETECTED METALS - AREA C GROUNDWATER NAWC WARMINSTER, PENNSYLVANIA

Chemical	Molecular Weight (gm/mol)	Partitioning Coefficient Range[1] (Kd)
Aluminum	26.98	NR
Antimony	121.75	NR
Arsenic	74.92	1.0 - 8.3 (trivalent)
Barium	137.34	NR
Beryllium	9.01	NR
Cadmium	112.40	1.3 - 2.7
Chromium	51.99	470 - 150,000 (trivalent) 1.2 - 1,800 (hexavalent)
Cobalt	58.93	0.2 - 1,800
Copper	63.54	1.4 - 333
Iron	55.85	1.4 - 1,000
Lead	207.19	4.5 - 7,640
Magnesium	24.31	1.6 - 13.5
Manganese	54.94	0.2 - 10,000
Mercury	200.59	NR
Potassium	39.10	2.0 - 9.0
Sodium	22.99	NR
Thallium	204.37	2,000 - 510,000
Vanadium	50.94	NR
Zinc	65.38	0.1 - 8,000

NR Value not reported.

(1) Dragun, 1988.

concentrations. Contaminants with a specific gravity less than 1 will tend to float, whereas contaminants with a specific gravity greater than 1 will tend to sink.

5.1.2 Vapor Pressure

Vapor pressure provides an indication of the rate at which a chemical volatilizes from both soil and water. It is of primary significance at environmental interfaces, such as surface soil/air and surface water/air. Volatilization is not as important when evaluating contaminated groundwater and subsurface soils. However, in order to conservatively evaluate chemical exposures at the five sites, it will be considered. Chemicals with high vapor pressures are expected to enter the atmosphere more readily than chemicals with low vapor pressures. Semivolatile organic and pesticides and PCB compounds are considered to have low vapor pressures.

5.1.3 Solubility

The rate at which a chemical is leached from a waste deposit by infiltrating precipitation is directly proportional to its water solubility. Several of the detected volatile organic compounds have relatively high water solubilities, but the low concentrations observed in soils indicate low potential for significant desorption. The pesticides and PCBs are considered to have low solubilities and also would not be expected to migrate through the soil column and reach the water table.

The solubility of inorganics is strongly influenced by their valence state(s) and forms (hydroxides, oxides, carbonates, etc.). The solubility is also strongly dependent on pH, Eh, and the presence of other ionic species in solution (the Debye-Hückel theory). Solubility products reported in the literature vary with the type of complex formed. Based on review of the analytical data for soils and groundwater at all sites, it is believed that the metals in soil are not adversely impacting the groundwater.

5.1.4 Octanol-Water Partitioning Coefficient (Kow)

The octanol/water coefficient is a measure of the equilibrium partitioning of chemicals between octanol and water. A linear relationship between the K_{ow} and the uptake of chemicals by fatty tissues of animal and human receptors (the bioconcentration factor) has been determined (Lyman et al., 1990). It is also useful in characterizing the sorption of compounds by organic soils where experimental values are not available. Larger organic molecules such as semivolatiles and pesticides and PCBs are very likely to partition to fatty tissues, while less complex organic chemicals have lower Kow values.

5.1.5 Organic Carbon Partitioning Coefficient (Koc)

The soil/sediment partition (organic carbon partition) coefficient indicates the tendency of a chemical to bind to soil particles containing organic carbon. Chemicals with high K_{oc}s generally have low water solubilities and vice versa. This parameter may be used to infer the relative rates at which more mobile chemicals are transported in groundwater. Complex organic chemicals are relatively immobile and are preferentially bound to the soil phase. These compounds are not subject to rapid groundwater transport. These immobile chemicals are, however, easily transported by erosional processes when they are present in surface soils.

5.1.6 Distribution Coefficient (Kd)

The soil-water partitioning (distribution) coefficient is a measure of the equilibrium distribution of a chemical or ion in soil/water systems. The distribution of organic chemicals is a function of both the K_{oc} and the amount of organic carbon in the soil.

5.1.7 Henry's Law Constant (H)

Both the vapor pressure and the water solubility are of use in determining volatilization rates from surface water bodies and groundwater. The ratio of these two parameters (the Henry's Law constant) is used to calculate the equilibrium contaminant concentrations in the vapor versus the liquid phases for dilute solutions. In general, chemicals with a Henry's Law constant less $5e^{-8}$ atm-m^3/mole should volatilize very little and be present only in minute amounts in the atmosphere or in soil gas. Henry's Law constant will be used to calculate the equilibrium soil gas vapor concentration for volatile organic compounds in groundwater.

5.2 CONTAMINANT PERSISTENCE

The persistence of the classes of organic contaminants is discussed in this section. The text will address general classes of the detected chemicals because the fate of chemicals in the environment is usually similar for chemicals within a particular chemical family.

5.2.1 Ketones

Ketones are characterized by high aqueous solubility, volatility, and are readily biodegradable in both soil and water. Hydrolysis is not considered to be a significant fate process for this class of chemicals. The bioacculumation of ketones is not significant, due to low octanol/water partitioning coefficient. The only

detected ketone, acetone, is not pervasive at any site and is not noted to be a historically prevalent contaminant at any of the previously investigated sites in the general area.

5.2.2 Chlorinated Aliphatics

Research has demonstrated that aerobic bacteria predominantly degrade organic compounds containing zero, one, or two halogens, while anaerobic bacteria predominate when more halogens are present. Thus, highly chlorinated aliphatic hydrocarbons such as tetrachloroethene are subject to reductive dehalogenation via the action of anaerobic bacteria. It does not appear that appreciable degradation of highly halogenated aliphatics occurs in aerobic aquatic systems or unsaturated soils (Lyman, et al., 1982).

The transformation pathways for chlorinated aliphatic hydrocarbons in soil systems has been documented by Dragun et al. (1988). Tetrachloroethene and trichloroethene are transformed via reductive dechlorination to 1,1-dichloroethene and 1,2-dichloroethene isomers. The terminal product of the transformation series is vinyl chloride, the chlorinated ethene with highest toxicity.

5.2.3 Phthalate Esters

Phthalate esters are considered to be relatively persistent environmental contaminants. Although numerous studies have demonstrated that phthalate esters undergo biodegradation, it appears that this is a very slow process in both soil and surface water. Certain microorganisms have been shown to excrete products that increase the solubility of phthalate esters and enhance their biodegradation (Gibbons and Alexander, 1989). Biodegradation of bis(2-ethylhexyl)phthalate and other phthalate esters is an important fate mechanism, as is bioaccumulation. Hydrolysis of phthalate esters is very slow, with calculated half-lives of 3 years (dimethylphthalate) to 2,000 years (bis(2-ethylhexyl)phthalate) (EPA, December 1979). Similarly, photolysis is considered to be an insignificant degradation mechanism (EPA, December 1982).

5.2.4 Monocyclic Aromatic Hydrocarbons

Monocyclic aromatic compounds such as benzene, toluene, ethylbenzene, and xylenes are not considered to be persistent environmental contaminants in comparison to PAHs, phthalate esters, and metals. Monocyclic aromatics are subject to degradation in both soil and water via the action of microorganisms. The biodegradation of these compounds in the soil matrix is dependent on the abundance of microflora, macronutrient availability, soil reaction (pH), temperature, oxygen, etc.

Although these compounds are amenable to microbial degradation, the rate of degradation cannot be predicted without information of the availability of nutrients and the type of bacteria present. If these contaminants discharge to a surface water body, volatilization and biodegradation may occur relatively rapidly. For example, a reported first-order biodegradation rate constant for benzene is 0.11 day^{-1} in aquatic systems (Lyman et al., 1990). This corresponds to an aquatic half-life of approximately 6 days. Other monocyclic aromatics are subject to similar degradation processes in aquatic environments (EPA, December 1982).

Additional degradation processes such as hydrolysis and photolysis are considered to be insignificant fate mechanisms for monocyclic aromatics (EPA, December 1982). However, some monocyclic aromatic compounds, such as benzene and toluene, have been shown to undergo clay-, mineral-, and soil-catalyzed oxidation (Dragun, 1988).

5.2.5 Polynuclear Aromatic Hydrocarbons (PAHs)

Although not detected in the groundwater at Area C, PAHs are known to be present in the soil immediately surrounding the fire training area (Site 8). PAHs are common constituents of oil and grease. Landspreading applications have indicated that PAHs are amenable to microbial degradation. Studies have demonstrated that PAHs are much more amenable to degradation in soil matrices than in aquatic environments (EPA, December 1979). Under existing site conditions, the rate of microbial degradation cannot be predicted without knowledge of microbial populations. PAHs do not contain functional groups that are susceptible to hydrolytic actions, and hydrolysis is considered to be an insignificant degradation mechanism. Photolysis may be a major degradation mechanism in aquatic environments, but is probably insignificant in surface soil.

5.2.6 Pesticides

Whether pesticides are sprayed, dusted, or applied directly to the soil, the soil is the ultimate sink for these chemicals. Pesticides typically have a high affinity for binding to organic particulates in soil, are very limited as to water solubility, and have very low vapor pressures and Henry's Law constant values. Consequently, the chemicals are some of the most immobile of environmental contaminants.

Endosulfan II, detected in one groundwater sample, is noted to be hydrolyzed readily in a base catalyzed environment, negligibly in neutral and acidic environments, and is also quite resistive to bacterial biotransformation. It is unusual that the pesticide was detected in the groundwater at all, and it is believed to be a false positive detection. However, conservative accounting of endosulfan II is required, and being

dissolved in the groundwater, the fate of this chemical will likely be downgradient migration with the bulk flow and possible partitioning to stationary organic material in the soil.

5.2.7 Metals

The transport and fate of metals in the environment are primarily controlled by sorption to soil/sediment material. The metal-organic relationships, both in soil and water, increase in importance as the organic carbon content increases. Some metals such as arsenic are extremely soluble and mobile in the environment. Many other metals such as nickel, selenium, zinc, and copper have an affinity for hydrous iron and manganese oxides, as well as for organic materials, and are therefore preferentially adsorbed to soil. The mobility of most metals increases as the soil pH decreases.

5.3 CONTAMINANT MIGRATION ROUTES

Based on the positively detected chemicals and associated analytical results for Area C, general conclusions can be made with respect to contaminant fate and transport and the possible exposure endpoints. These conclusions are discussed on a site-specific basis.

Groundwater chemical contaminants can migrate from the original source of the release. The most common transport mechanism is water infiltration through a contaminated zone, where partitioning from solid to aqueous phase can occur. The potential amount of chemical solving into infiltration water is determined by a number of factors including residence time, solubility, partitioning factor, and pH of infiltration water. The dissolved chemicals continue downward migration and are able to interact with stationary (soil) particles in the saturated and/or unsaturated zones.

After percolation through the capillary zone, dissolved contaminants are then able to enter groundwater where transport can occur in bulk (advection). The chemical concentrations in groundwater increase significantly shortly after initial groundwater impact to a maximum level. The longer-term effects at the source are a gradual decrease in the concentrations over time as chemical removal from the source area occurs. Short-term variations in release rate and impact to groundwater can occur, but long-term trends of decreased levels are usually observed. Chemical diffusion and dispersion throughout the groundwater flow regime occurs as the groundwater flows.

As materials are transported by the groundwater, a number of processes occur which can reduce the concentration of the chemicals. Diffusion and attenuation effects are nontransformational mechanisms that result in a direct decrease in chemical concentration. Chemical and biological reactions with dissolved

chemicals can also result in decreases in chemical concentration. The products, however, may have significantly different chemical, transport, and toxicological properties from the parent compounds.

Groundwater chemical contamination can vary over periods of time as climatic and meteorological conditions change. Also, as materials from the release (source) area are depleted, lower concentrations of contaminant are released into the groundwater. Eventually, the impacts to groundwater cease, and residual chemicals are subjected to dilution, and degradation via natural mechanisms.

The following subsections will summarize contaminant migration potential and possible fate for the chemicals detected at the sites in Area C.

5.3.1 Site 4

The chemicals detected at and near Site 4 include low concentrations of acetone, toluene, di-n-butyl phthalate, endosulfan II, and metals. The results obtained in the downgradient wells for Site 4 indicate that the migration of chemicals from the former trenching area is limited off Base. Detected volatile organic chemicals in these shallow wells, acetone and toluene, are soluble and are typically very mobile in water. If the groundwater is being impacted by contaminants at Site 4, the current degree of impact is limited. Long-term trends cannot be identified, as limited soil (source) data are available, and the period over which monitoring has occurred is relatively short.

Although metallic constituents have been detected, it is not believed that the metals are part of a migrant groundwater contaminant plume. There are no notable changes in metals concentrations for either unfiltered or filtered samples when upgradient wells are compared to those that are downgradient.

5.3.2 Site 8 and Adjacent Areas

The detected contaminants in the groundwater at Site 8 and in adjacent areas are associated with solvents. Detectable concentrations of acetone, tetrachloroethene, diethylphthalate, di-n-butylphthalate, and endosulfan II are noted. All chemicals except the pesticide are mobile in the groundwater, the phthalate esters having a relatively high affinity for partitioning to organic carbon in soil. Based on the downgradient range of the contaminant plume (over 500 feet) and the detected concentrations of these chemicals in the Area C groundwater, it may be inferred that the source area is on the Base, perhaps near the maintenance area. The mobile nature of the contaminants will allow them to migrate with the groundwater. Diffusion and dispersion mechanisms, as well as biological and, to a limited extent, chemical transformations may further

reduce the downgradient concentrations of these chemicals. It is not likely that the source is depleted, as increasing concentrations of contaminants are noted for wells which are closer to the assumed source area.

6.0 RISK ASSESSMENT

The risk assessment provides a quantitative assessment of the risks posed to human receptors which may be exposed to contaminants detected in the groundwater at Area C. The process consists of several elements including:

- **Data Evaluation**. Provides interpretation of analytical data with respect to the risk assessment and identifies potential chemicals of concern to human health based on frequency of detection, maximum concentrations, and individual chemical toxicity.

- **Exposure Assessment**. Provides a quantified measure of exposure by combining analytical information with defined exposure input parameters which are consistent with, and defined by, a conceptual site model.

- **Toxicity Assessment**. The section presents toxicological information for the identified potential chemicals of concern. Also included in this discussion is a summary of applicable State and Federal requirements and standards.

- **Risk Characterization**. This portion of the risk assessment integrates the results of the exposure and toxicity assessments to provide a numerical risk estimate for human receptors identified in the conceptual site model. The results of the characterization are interpreted to identify the risk levels which may be considered "acceptable" or "unacceptable."

The risk assessment process is designed to be extremely conservative. The risks presented are "worst case," estimates associated with the most sensitive receptors. The methods used for the risk assessment are consistent with current U.S. EPA guidance as outlined in:

- Risk Assessment Guidance for Superfund - Volume 1 - Human Health Evaluation Manual (Part A), U.S. EPA, December 1989.

- Risk Assessment Guidance for Superfund - Volume 1 - Human Health Evaluation Manual (Part A) "Supplemental Guidance" - Standard Default Exposure Factors, U.S. EPA, March 25, 1991.

- Dermal Exposure Assessment: Principles and Applications, U.S. EPA, January 1992.

6.1 DATA EVALUATION

Data evaluation is the process whereby analytical information is interpreted with the goal of selecting chemicals which pose significant risks to receptors. Available analytical information is reviewed in association with the geological information to determine the chemicals and associated concentrations that receptors may realistically encounter.

6.1.1 Chemicals of Concern

The selection of potential chemicals of concern begins with identification of all positively detected groundwater chemicals. All organic chemicals detected are assumed to be anthropogenic in origin, and consequently, are retained as potential chemicals of concern.

Metals are screened by a comparison of detected concentrations to background concentrations and to U.S. EPA Region III screening concentrations. Background was established for Area C using data from background wells BG-2, BG-6, HN-26S and HN-26I, and HN-01I and HN-01D. 95% Upper confidence limits (UCLs) on the arithmetic or geometric means of metals results which exceeded screening concentrations are retained as chemicals of potential concern. Other metals with low toxicity (aluminum) and those known to be essential nutrients (calcium, iron, magnesium, potassium, and sodium) were excluded from the list of potential chemicals of concern. Table 6-1 presents a summary of the detected chemical UCLs, background screening levels, and final screening values for detected groundwater chemicals.

6.1.2 Representative Concentrations

Chemical-specific representative concentrations are used in the quantitative risk assessment to determine the chemical concentration that a receptor may contact during the exposure scenarios. The representative concentration can also be used as a conservative estimate of the overall amount of a contaminant that may be present in an environmental medium. The concentrations may be either taken directly from the analytical data (i.e., a maximum concentration) or may be obtained from a statistical analysis of a set of data.

An example of a statistically determined representative concentration is an upper confidence limit (UCL) of the mean of a data set. The numerical value is determined differently for normal or log-normal data distributions, and can provide a reasonable estimate of the chemical contact concentration. Data distribution characteristics are determined by use of the Shapiro-Wilk W-Test for goodness of fit. A sample calculation for distribution analysis is provided in Appendix F. Distribution evaluation is discussed further in Section 6.1.3.

TABLE 6-1

POSITIVELY DETECTED BACKGROUND CHEMICALS - GROUNDWATER DATA DISTRIBUTION AND 95% UCL CONCENTRATIONS NAWC WARMINSTER, PENNSYLVANIA

Chemical	Data Distribution	95% UCL Concentration (μg/L)	U.S. EPA Region III Screening Value[3] (μg/L)	Final Screening Concentration (μg/L)
Acetone	ND	NC	370	370
Toluene	[1]	NC	75	75
Tetrachloroethene	ND	NC	1.1	1.1
Diethylphthalate	ND	NC	2900	2900
Di-n-butylphthalate	ND	NC	370	370
Endosulfan II	ND	NC	22	22
Antimony (Total)	ND	-	1.5	1.5
Antimony (Dissolved)	Normal[1]	44.7	1.5	1.5
Arsenic	Normal[1]	5.8	1.1	1.1
Barium	Log-normal	628[2]	260	260
Beryllium	Normal[1]	1.5	0.016	0.016
Cadmium	Normal[1]	2.7	1.8	1.8
Chromium	Normal[1]	5.5	18[4]	5.5
Cobalt	Normal[1]	3.3	NA	3.3
Copper	Normal	10	140	10
Lead	Normal[1]	13.6	NA	13.6
Manganese (6 wells)	Normal[1]	422	18	18
Manganese (15 wells)[5]	NA	2,200	18	18
Mercury	Normal[1]	0.17	1.1	0.17
Thallium	ND	-	2 (MCL)	2
Vanadium	Normal[1]	3.7	26	3.7
Zinc	Normal[1]	33.2	1100	33.2

NA Not available.
ND Chemical not detected in background samples (BG-2, BG-6, HN01-I, HN01-D, HN26-S, HN26-I).
NC UCL concentration not calculated, all organic chemicals assumed to be anthropogenic in origin.

(1) Results of W-Test inconclusive. Distribution determined to provide more conservative (lesser) background concentration.
(2) UCL exceeds maximum reported background concentration. Reported value is maximum background concentration.
(3) Values obtained from U.S. EPA Region III technical guidance manual "Selecting Exposure Routes and Chemicals of Concern by Risk-Based Screening," tap water exposure.
(4) Value for hexavalent chromium presented for conservatism.
(5) From Phase II RI Report (Halliburton NUS, 1992).

For the Area C and Site 4 downgradient risk assessments, 95% UCLs for the chemicals detected at all monitoring wells were used as representative concentrations. If the calculated UCL exceeds the maximum detected concentration for a particular analyte, the maximum concentration is used as the representative concentration.

For normally distributed data, the calculation of the representative concentration is a two-step process. First, the standard deviation of the sample set must be determined, as follows:

$$S = \sqrt{\frac{(\sum X_i)^2 - \frac{1}{n} \sum X_i^2}{n - 1}}$$

where:

S	=	*Standard deviation*
X_i	=	*Individual sample value*
n	=	*Number of samples*
X	=	*Mean sample value*

The one-sided upper 95 percent confidence limit (UCL) is then calculated as follows:

$$UCL = X + t\,[S/n^{1/2}]$$

where:

X	=	*Arithmetic average value*
t	=	*One-sided t distribution factor* ($t_{0.95}$)
S	=	*Standard deviation*
n	=	*Number of samples*
UCL	=	*Representative concentration*

For log-normally distributed data, the representative concentration is calculated using the following equation:

$$UCL = \exp\left[\bar{X} + 0.5S^2 + \left[\frac{HS}{(n-1)^{1/2}}\right]\right]$$

where:

UCL	=	*Representative concentration*
exp	=	*Constant (base of the natural* log, *e)*
$\bar{X}$	=	*Mean of transformed data*
S	=	*Standard deviation of transformed data*
H	=	*H–statistic (e.g., the table published in Gilbert,* 1987)
n	=	*Number of samples*

This equation uses individual sample results that are transformed by taking their natural logarithm.

For nondetected results, one-half of the reported quantitation limit was used as the sample result. For small sample sets or sample sets with all positive results less than one-half the detection limit, the UCL can exceed the maximum detected concentration. In these cases, the maximum concentration was selected as the representative concentration. Sample calculations are provided in Appendix D.

When duplicate samples are evaluated, the results are averaged and counted as one sample. One-half the detection limit is used for nondetects. However, there are instances where one-half the detection limit exceeds the other sample's positive detection (e.g., with base/neutral or acid extractable compounds), in which case the positive detection is considered as the sample result.

6.1.3 Data Distribution Evaluation

Chemical-specific data evaluation for each of the site media were performed using the Shapiro and Wilk "W-Test" for goodness of fit to determine whether a given data set is normally or log-normally distributed (Gilbert, 1987). The test accepts or rejects a null hypothesis about a given population (i.e., that a population is or is not normally or log-normally distributed).

Despite the utility of the W-Test in evaluating distribution characteristics, the test is often times inconclusive (especially when evaluating small populations). To provide as conservative an assessment as possible,

inconclusive W-Test results are interpreted to provide the lowest UCL value (for background) or highest UCL value (for Area C and Site 4 downgradient).

Summaries of the exposure point concentrations used in the exposure assessment for Area C and Site 4 downgradient monitoring well data are presented in Tables 6-2 and 6-3, respectively.

6.2 EXPOSURE ASSESSMENT

The purpose of this section is to evaluate the potential for human exposure to the hazardous chemicals in the environmental media at the site. This section characterizes the exposed populations, identifies actual or potential exposure routes, and provides exposure estimates. The nature and extent of contamination upon which the exposures are based is presented in Section 4.0.

To determine whether there is an actual or potential exposure at the site, the most likely pathways of contaminant release and transport as well as the human and environmental activity patterns at the site must be considered. A complete exposure pathway has three components: (1) a source of chemicals that can be released to the environment; (2) a route of contaminant transport through an environmental medium; and (3) an exposure or contact point for a human or environmental receptor.

6.2.1 Receptors

There are currently no plans to develop the site for residential use, but because there are no land development restrictions in place, a current and future residential land use scenario will be considered in this risk assessment. This future land use scenario includes the installation of domestic wells and associated exposures, and does not include other potential residential-type exposures such as ingestion of soil by small children. Human receptors that may be exposed to groundwater from Area C include both adult and child residents. The exposure assessment will include an evaluation for both receptors.

6.2.2 Exposure Routes

There is only one environmental medium at the site for which risk assessment will be performed for this RI. The groundwater at Area C, although not currently used, is of sufficient quality to be considered a possible source of potable water for residential use. Possible exposure routes associated with household water use include ingestion of and dermal contact with water, and inhalation of volatile chemicals emitted during showering or bathing. Ingestion of water from the tap is considered a complete exposure pathway for both adult and child receptors. Adults tend to shower more than bathe, unlike small children. For a small child

TABLE 6-2

CHEMICAL OF CONCERN IDENTIFICATION
AREA C GROUNDWATER
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Data Distribution	95% UCL Concentration (μg/L)	Screening Concentration (μg/L)	Retained as Chemical of Concern?
Acetone	Log-normal	38	370	No
Toluene	Normal[1]	0.7	75	No
Tetrachloroethene	Normal[1]	5	1.1	Yes
Diethylphthalate	Normal[1]	5	2900	No
Di-n-butylphthalate	Normal[1]	4	370	No
Endosulfan II	Normal[1]	0.08	22	No
Antimony (Total)	Normal[1]	19	1.5	Yes
Antimony (Dissolved)	Log-normal	35.0	1.5	Yes
Arsenic	Normal[1]	4.1	1.1	Yes
Barium	Log-normal[1]	329	260	Yes
Beryllium	Normal[1]	0.66	0.016	Yes
Cadmium	Normal[1]	2.4	1.8	Yes
Chromium	Normal[1]	6.6	5.5	Yes
Cobalt	Normal[1]	3.7	3.3	Yes
Copper	Normal[1]	15.7	10	Yes
Lead	Log-normal[1]	3.2	13.6	No
Manganese	Log-normal	1600	18	Yes
Mercury	Normal[1]	0.097	0.17	No
Thallium	Normal[1]	2.2	2	Yes
Vanadium	Normal[1]	5.6	3.7	Yes
Zinc	Log-normal	225[2]	33.2	Yes

(1) Results of W-Test inconclusive. Distribution determined to provide more conservative (greater) representative concentration.

(2) Calculated 95% UCL concentration exceeds maximum concentration detected. Representative concentration used is equal to maximum concentration detected for this chemical.

TABLE 6-3

CHEMICAL OF CONCERN IDENTIFICATION
SITE 4 - DOWNGRADIENT WELLS
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Data Distribution	95% UCL Concentration (μg/L)	Screening Concentration (μg/L)	Retained as Chemical of Concern?
Acetone	Log-normal	70	370	No
Toluene	Normal[1]	0.9	75	No
Antimony (Total)	Normal[1]	20.9	1.5	Yes
Antimony (Dissolved)	Log-normal[1]	37.8	1.5	Yes
Arsenic	Log-normal	4.1	1.1	Yes
Barium	Log-normal[1]	458	260	Yes
Cadmium	Log-normal[1]	2.5	1.8	Yes
Chromium	Normal[1]	7.0	5.5	Yes
Copper	Log-normal[1]	28.7	10	Yes
Lead	Log-normal[1]	3.2	13.6	No
Manganese	Log-normal[1]	1,840[2]	18	Yes
Mercury	Log-normal[1]	0.11	0.17	No
Thallium	Normal[1]	2.4	2	Yes
Vanadium	Log-normal[1]	10.9	3.7	Yes
Zinc	Log-normal[1]	225[2]	33.2	Yes

(1) Results of W-Test inconclusive. Distribution determined to provide more conservative (greater) representative concentration.

(2) Calculated 95% UCL concentration exceeds maximum concentration detected. Representative concentration used is equal to maximum concentration detected for this chemical.

less than 6 years old, the immersion in bath water provides significant dermal exposure. However, the quiescent water surface reduces contaminant transfer to the vapor phase and, along with an open bathroom allowing a high air exchange rate, reduces the significance of the inhalation exposure route.

During showers, adults are exposed to volatiles emitted from the spray and increased temperatures provide higher vapor saturation concentrations. Under these circumstances, inhalation exposures are significant not only in the shower, but the entire time that the receptor occupies the shower room.

Dermal contact exposures in the shower are lessened somewhat by short residence time of water on skin, the use of soaps and surfactants, and dissolved-phase chemical depletion from volatilization. Consequently, the dermal exposure pathway in the shower is considered incomplete.

6.2.3 Exposure Estimates

The estimation methods and models used in this section are consistent with current EPA risk assessment guidance (U.S. EPA, December 1989 and March 25, 1991). Exposure estimates associated with each exposure route are presented below. All exposure scenarios incorporate the representative contaminant concentrations in the estimation of intakes. Therefore, only one exposure scenario was developed for each exposure route/receptor combination.

Noncarcinogenic risks are estimated using the concept of an average annual exposure. The intake incorporates terms describing the exposure time and/or frequency that represent the number of hours per day and the number of days per year that exposure occurs. This is used with a term known as the averaging time, which converts the daily exposure frequency and duration to an annual exposure by dividing by 365 days per year of exposure. Noncarcinogenic risks for some exposure routes (e.g., soil contact) are generally greater for children than for adults because of their much lower body weights and similar or higher ingestion rates.

Carcinogenic risks, on the other hand, are calculated as an incremental lifetime risk, and therefore incorporate terms to represent the exposure duration (years) over the course of a lifetime (70 years, or 25,550 days). Carcinogenic risks may not be calculated for children because they are generally lower than those calculated for adults because of their shorter exposure duration at a lower body weight.

Three exposure routes for potential residential receptors are examined for exposure to contaminated groundwater at Area C. These exposure routes include ingestion of and dermal contact with water for adult residents, and inhalation of volatile chemicals emitted during showering for adult residents. Children are

assumed not to take showers, therefore they are not considered for the volatile exposure scenario. The methods used to assess exposure dose estimates associated with these routes of exposure are discussed in the following text.

Ingestional exposures are characterized using the following expression (U.S. EPA, December 1989):

$$Dose = \frac{C_{water} \times IngR \times EF \times ED}{BW \times AT}$$

Where:	Dose	=	Dose estimate (mg/Kg-day)
	C_{water}	=	Groundwater exposure concentration (mg/L)
	IngR	=	Ingestion rate (L/day)
	EF	=	Exposure frequency (days/year)
	ED	=	Exposure duration (years)
	BW	=	Body weight (kg)
	AT	=	Averaging time (period of time over which exposure is averaged - days)

Under the residential use scenario, the following input parameters are used to estimate intakes. Adult residents are assumed to ingest 2 liters of water per day, 350 days per year, over a 30-year exposure duration (U.S. EPA, December 1989 and March 25, 1991). Child residents are assumed to ingest 1 liter of water per day, 350 days per year, for 6 years. Body weights are specified as 70 Kg for adults and 15 Kg for children. A summary of input parameters is provided in Table 6-4.

Dermal exposures for residents during bathing (children) is estimated as follows (EPA, December 1989):

$$Dose = \frac{C_{water} \times PC \times SA \times ET \times EF \times ED \times CF}{BW \times AT}$$

Where:	Dose	=	Absorbed chemical dose (mg/Kg-day)
	C_{water}	=	Groundwater exposure concentration (mg/L)
	PC	=	Dermal permeability constant of chemical (cm/hour)
	SA	=	Skin surface area available for contact (cm^2)
	ET	=	Exposure time (hours/day)
	EF	=	Exposure frequency (days/year)
	ED	=	Exposure duration (years)
	BW	=	Body weight (kg)

TABLE 6-4

SUMMARY OF EXPOSURE ASSESSMENT INPUT PARAMETERS
RESIDENTIAL GROUNDWATER EXPOSURES
AREA C
NAWC WARMINSTER, PENNSYLVANIA

Parameter	Value	Rationale/Source
Chemical concentration in groundwater (C_{water})	Chemical-specific representative concentration (mg/L)	U.S. EPA, December 1989
Groundwater ingestion rate (IngR)	2 L/day (adult) 1 L/day (child)	U.S. EPA, December 1989 and March 25, 1991
Air inhalation rate (InhR)	20 m^3/day	Outdoor air respiration rate/ U.S. EPA, March 25, 1991
Dermal permeability constant (PC)	Chemical specific value (cm/hr)	U.S. EPA, January 1992
Skin surface area available for contact (SA)	7,280 cm^2 (child)	U.S. EPA, May 1989 and December 1989
Volatile chemical generation rate (S)	Chemical specific rate ($\mu g/m^3$-min)	Foster and Chrostowski, 1987
Inhalation exposure time constant (K)	41.6 min	Calculated value
Exposure time (ET)	0.25 hr	Estimate of time spent in shower
Exposure frequency (EF)	350 days/yr	U.S. EPA, December 1989 and March 25, 1991
Exposure duration (ED)	30 yr (adult) 6 yr (child)	U.S. EPA, December 1989 and March 25, 1991
Body weight (BW)	70 Kg (adult) 15 Kg (child)	U.S. EPA, December 1989 and March 25, 1991
Averaging time (AT)	ED x 365 days/yr (noncarcinogens) 70 yr x 365 days/yr (carcinogens)	U.S. EPA, December 1989 and March 25, 1991
Bathroom air exchange rate (R_a)	0.0083 min^{-1}	Foster and Chrostowski, 1987
Time spent in shower/bath (D_s)	15 min	Estimated value
Time spent in bathroom (D_t)	20 min	Estimated value

AT	=	Averaging time (period of time over which exposure is averaged - days)
CF	=	Conversion Factor ($L/10^3\ cm^3$)

Although it is recognized that receptors do not bathe completely under water, the dermal assessment conservatively quantifies exposure as though it is via immersion. Quantitation is based on the assumption that groundwater contaminants are present in dilute solution and that percutaneous absorption is primarily controlled by the flux of water. The permeability constant of water is assumed to be 0.0008 cm/hour (U.S. EPA, April 1988). Chemical-specific permeability constant values are used as available (U.S. EPA, January 1992). Skin surface area available for contact is specified as 7,280 cm^2 for small children (U.S. EPA, December 1989), assuming whole body contact. The exposure time is set at 0.25 hours/day, and the exposure frequency is set at 350 days/year. Exposure duration is set at 30 years for adults and 6 years for children. Table 6-4 provides a summary of the input parameters used for the dermal exposure to groundwater scenario.

Inhalational exposures during showering were estimated using a mass transfer model developed for this exposure route, in combination with an intake estimation model. The mass transfer model accounts for inhalation that occurs during a shower, as well as after the shower while the receptor remains in the bathroom. The method employed is as follows (U.S. EPA, December 1989; Foster and Chrostowski, 1987):

$$Dose = \frac{S \times K \times InhR \times EF \times ED \times CF}{BW \times AT \times R_a}$$

and

$$K = D_s + \frac{\exp^{-R_a \times D_t}}{R_a} - \frac{\exp^{R_a(D_s - D_t)}}{R_a}$$

Where:			
	Dose	=	Inhalation exposure dose (mg/Kg-day)
	S	=	Volatile Chemical Generation Rate ($\mu g/m^3$-min)
	InhR	=	Inhalation Rate (L/min)
	EF	=	Exposure Frequency ($year^{-1}$)
	ED	=	Exposure Duration (years)
	BW	=	Body Weight (Kg)
	AT	=	Averaging Time (period of time over which exposure is averaged - days)
	R_a	=	Air exchange Rate (min^{-1})
	K	=	Constant (min)
	D_s	=	Shower Duration (min)

D_t	=	Total Time in Bathroom (min)
CF	=	Conversion Factor (10^{-6} mg-m^3/μg-L)

The volatile chemical generation rate was estimated using the Foster and Chrostowski mass transfer model, which is based on a two-phase film theory. The model employs contaminant-specific mass transfer coefficients, Henry's Law constants, droplet drop time, viscosity, temperature, etc. Specific details regarding the application of the mass transfer model are included in Appendix F.

It is assumed that small children do not take showers, and are therefore not exposed in this manner.

The inhalation rate was specified as 14 L/min for a 70-kg adult. The exposure frequency was specified as 0.96 year^{-1} (i.e., one shower per day for 350 days per year), and the exposure duration was specified as 30 years over a 70-year lifetime. The air exchange rate was specified as 0.0083 min^{-1}, the shower duration as 15 minutes, and the total time in the bathroom as 20 minutes.

Table 6-4 presents a summary of the input parameters for the groundwater exposure routes described above. Tables 6-5 and 6-6 summarize estimated ingestion, dermal contact, and inhalation doses for Area C and Site 4 downgradient wells, respectively. Doses are calculated for exposure of total contaminant concentrations for unfiltered samples.

6.3 TOXICITY ASSESSMENT

The purpose of this section is to identify the potential health hazards associated with exposure to each of the chemicals of concern. A toxicological evaluation characterizes the inherent toxicity of a compound. The literature indicates that the chemicals of concern cause carcinogenic and/or noncarcinogenic health effects in humans. In addition, many of the chemicals have adverse effects on environmental receptors. Although the chemicals of concern may cause adverse health effects, dose-response relationships and the potential for exposure must be evaluated before the risks to receptors can be determined. Dose-response relationships correlate the magnitude of the intake with the probability of toxic effects, as discussed below.

6.3.1 Health Effects

An important component of the risk assessment process is the relationship between the intake of a chemical (the amount of a chemical that is absorbed by a receptor) and the potential for adverse health effects resulting from that intake. Dose-response relationships provide a means by which potential public health

TABLE 6-5

ESTIMATED EXPOSURE DOSES
RESIDENTIAL GROUNDWATER EXPOSURES
AREA C
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Adult Receptor (mg/Kg-day)						Child Receptor (mg/Kg-day)					
	Incidental Ingestion		Dermal Contact		Inhalation of Volatiles		Incidental Ingestion		Dermal Contact		Inhalation of Volatiles	
	Non-Carc.[1]	Carc.[2]	Non-Carc.	Carc.	Non-Carc.	Carc.	Non-Carc.[1]	Carc.[2]	Non-Carc.	Carc.	Non-Carc.	Carc.
Tetrachloroethene (current) (min)	6.9E-6	2.9E-6	NA	NA	2.6E-6	1.1E-6	1.6E-5	1.4E-6	1.4E-6	1.2E-7	NA	NA
(max)	8.5E-4	3.6E-4	NA	NA	3.2E-4	1.4E-4	2.0E-3	1.7E-4	1.7E-4	1.5E-5	NA	NA
Tetrachloroethene (future)	1.4E-4	5.9E-5	NA	NA	2.2E-5	5.1E-5	3.2E-4	2.7E-5	2.8E-5	2.4E-6	NA	NA
Antimony	5.2E-4	2.2E-4	NA	NA	NA	NA	1.2E-3	1.0E-4	2.2E-6	1.9E-7	NA	NA
Arsenic	1.1E-4	4.8E-5	NA	NA	NA	NA	2.6E-4	2.3E-5	4.8E-7	4.1E-8	NA	NA
Barium	9.0E-3	3.9E-3	NA	NA	NA	NA	2.1E-2	1.8E-3	3.8E-5	3.3E-6	NA	NA
Beryllium	1.8E-5	7.8E-6	NA	NA	NA	NA	4.2E-5	3.6E-6	7.7E-8	6.6E-9	NA	NA
Cadmium	6.6E-5	2.8E-5	NA	NA	NA	NA	1.5E-4	1.3E-5	2.8E-7	2.4E-8	NA	NA
Chromium	1.8E-4	7.8E-5	NA	NA	NA	NA	4.2E-4	3.6E-5	7.7E-7	6.6E-8	NA	NA
Cobalt	1.0E-4	4.3E-5	NA	NA	NA	NA	2.4E-4	2.0E-5	4.3E-7	3.7E-8	NA	NA
Copper	4.3E-4	1.8E-4	NA	NA	NA	NA	1.0E-3	8.6E-5	1.8E-6	1.6E-7	NA	NA
Manganese	4.4E-2	1.9E-2	NA	NA	NA	NA	1.0E-1	8.8E-3	1.9E-4	1.6E-5	NA	NA
Thallium	6.0E-5	2.6E-5	NA	NA	NA	NA	1.4E-4	1.2E-5	2.6E-7	2.2E-8	NA	NA
Vanadium	1.5E-4	6.6E-5	NA	NA	NA	NA	3.6E-4	3.1E-5	6.5E-7	5.6E-8	NA	NA
Zinc	6.2E-3	2.6E-3	NA	NA	NA	NA	1.4E-2	1.2E-3	2.6E-5	2.2E-6	NA	NA

NA Dose estimate not available, metals assumed to be nonvolatile.
1 Noncarcinogenic dose estimate.
2 Carcinogenic dose estimate.

TABLE 6-6

ESTIMATED EXPOSURE DOSES
RESIDENTIAL GROUNDWATER EXPOSURES
SITE 4 DOWNGRADIENT WELLS
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Adult Receptor (mg/Kg-day)						Child Receptor (mg/Kg-day)					
	Incidental Ingestion		Dermal Contact		Inhalation of Volatiles		Incidental Ingestion		Dermal Contact		Inhalation of Volatiles	
	Non-Carc.[1]	Carc.[2]	Non-Carc.	Carc.	Non-Carc.	Carc.	Non-Carc.[1]	Carc.[2]	Non-Carc.	Carc.	Non-Carc.	Carc.
Antimony	5.7E-4	2.5E-4	NA	NA	NA	NA	1.3E-3	1.2E-4	2.4E-6	2.1E-7	NA	NA
Arsenic	1.1E-4	4.8E-5	NA	NA	NA	NA	2.6E-4	2.3E-5	4.8E-7	4.1E-8	NA	NA
Barium	1.3E-2	5.4E-3	NA	NA	NA	NA	2.9E-2	2.5E-3	5.3E-5	4.6E-6	NA	NA
Cadmium	6.9E-5	2.9E-5	NA	NA	NA	NA	1.6E-4	1.4E-5	2.9E-7	2.5E-8	NA	NA
Chromium	1.9E-4	8.2E-5	NA	NA	NA	NA	4.5E-4	3.8E-5	8.1E-7	7.0E-8	NA	NA
Copper	7.9E-4	3.4E-4	NA	NA	NA	NA	1.8E-3	1.6E-4	3.4E-6	2.9E-7	NA	NA
Manganese	5.0E-2	2.2E-2	NA	NA	NA	NA	1.2E-1	1.0E-2	2.1E-4	1.8E-5	NA	NA
Thallium	6.6E-5	2.8E-5	NA	NA	NA	NA	1.5E-4	1.3E-5	2.8E-7	2.4E-8	NA	NA
Vanadium	3.0E-4	1.3E-4	NA	NA	NA	NA	7.0E-4	6.0E-5	1.3E-6	1.1E-7	NA	NA
Zinc	6.2E-3	2.6E-3	NA	NA	NA	NA	1.4E-2	1.2E-3	2.6E-5	2.2E-6	NA	NA

NA Dose estimate not available, metals assumed to be nonvolatile.
1 Noncarcinogenic dose estimate.
2 Carcinogenic dose estimate.

impacts may be quantified. The published information of doses and responses is used in conjunction with information on the nature and magnitude of human exposure to develop an estimate of potential health risks.

Standard Reference Doses (RfDs) and/or Cancer Slope Factors (CSFs) have been developed by the EPA for many organics and inorganics. This section provides a brief description of these parameters.

6.3.1.1 Reference Doses (RfDs)

The RfD is developed by the EPA for chronic and/or subchronic human exposure to hazardous chemicals and is solely based on the noncarcinogenic health effects imparted by a chemical. The RfD is usually expressed as a dose (mg) per unit body weight (Kg) per unit time (day). It is generally derived by dividing a no-observed-(adverse)-effect-level (NOEL or NOAEL) or a lowest-observed-adverse-effect-level (LOAEL) by an appropriate uncertainty factor. NOAELs, etc., are determined from laboratory or epidemiological toxicity studies. The uncertainty factor is based on the availability of toxicity data.

Uncertainty factors are generally applied as multiples of 10 to represent specific areas of uncertainty in the toxicity data. A factor of 10 is used to account for variations in population sensitivity, when extrapolating test results from animals to humans (interspecies variability), when a NOAEL derived from a subchronic study (instead of a chronic study) is used to develop the RfD, and when a LOAEL is used instead of a NOAEL. In addition, the EPA reserves the use of a modifying factor of up to 10 for professional judgment of additional uncertainties. The default value of the modifying factor is 1.

The RfD incorporates the surety of the evidence for chronic human health effects. Even if applicable human data exist, the RfD (as diminished by the uncertainty factor) still maintains a margin of safety so that chronic human health effects are not underestimated. Thus the RfD is an acceptable guideline for evaluation of noncarcinogenic risk, although the associated uncertainties preclude its use for precise risk quantitation.

6.3.1.2 Cancer Slope Factor (CSF)

CSFs are applicable for estimating the lifetime probability (assuming a 70-year lifetime) of human receptors developing cancer as a result of exposure to known or potential carcinogens. This factor is generally reported by the EPA in units of $(mg/Kg/day)^{-1}$ and is derived through an assumed low-dosage linear relationship and an extrapolation from high to low dose responses determined from animal studies. The value used in reporting the CSF is the upper 95 percent confidence limit.

6.3.1.3 Weight of Evidence

The weight of evidence designations indicate the likelihood that a chemical is a human carcinogen, based on both animal and human studies. The classification is as follows:

- A Known human carcinogen
- B Potential human carcinogen. B1 indicates that limited human data are available. B2 indicates that there is sufficient evidence of carcinogenicity in animals, but inadequate or no evidence in humans.
- C Possible human carcinogen
- D Not classifiable as to human carcinogenicity
- E Evidence of noncarcinogenicity in humans

6.3.1.4 Dermal Absorption Adjustment

Although exposure route-specific reference doses and cancer slope factors are available for oral and inhalation exposure routes, the difficulty associated with performing an epidemiological study for dermal exposures prohibits accurate assessment of toxicity via dermal absorption. As a default measure, U.S. EPA guidance suggests using oral reference doses and cancer slope factors which have been modified to account for the gastrointestinal absorption.

Readily absorbed chemicals (i.e., volatile organics, etc.) can be assumed to be absorbed 100% through the GI tract, whereas most metals are absorbed poorly in the digestive tract. Therefore, for animal studies performed by gavage, volatile chemicals are almost entirely absorbed, while metals are only minimally retained. The administered dosage is approximate equal to the absorbed dose for the volatile chemical, but the absorbed dose is vastly different from the administered dosage in the case of the metal. Since dermal risk assessment methodology accounts for the transdermal transport of chemicals into the bloodstream, absorbed dose values must be used.

The use of adjusted oral data permits assessment of the effects associated with the absorbed amount of chemical which has actually entered the bloodstream. The chemical-specific modification for reference doses and cancer slope factors is performed as follows:

$$RfD_{Dermal} = \frac{RfD_{oral}}{ABS_{GI}}$$

$$CSF_{dermal} = CSF_{oral} \times ABS_{GI}$$

Table 6-7 provides a summary of the dermal dose-response data for the detected groundwater chemicals at Area C.

6.3.2 Applicable or Relevant and Appropriate Regulation (ARARs)

This section presents the available regulatory standards or guidelines for all of the groundwater chemicals of concern at Area C. Currently, the enforceable regulatory standards for exposures to groundwater include Federal Maximum Contaminant Levels (MCLs) and Commonwealth of Pennsylvania groundwater quality standards. Some chemicals do not have regulatory limits promulgated, so other numerical comparison must be made. These to be considered (TBC) values are nonenforceable criteria and may be used for comparative purposes to infer health risks and environmental impacts. Relevant TBC guidelines include Maximum Contaminant Level Goals (MCLGs) and Health Advisories.

6.3.2.1 Maximum Contaminant Levels (MCLs)

MCLs are enforceable standards promulgated under the Safe Drinking Water Act and are designed for the protection of human health. MCLs are based on laboratory or epidemiologic studies and apply to drinking water supplies consumed by a minimum of 25 persons. They are designed for prevention of human health effects associated with lifetime exposure (70 years) of an average adult (weighing 70 Kg) who consumes 2 liters of water per day, but they also reflect the technical feasibility of removing the contaminant from the water. These enforceable standards also reflect the fraction of toxicant expected to be absorbed by the gastrointestinal tract.

6.3.2.2 Commonwealth of Pennsylvania Safe Drinking Water Regulations

The Commonwealth of Pennsylvania, under the Pennsylvania Code, Title 25, Chapter 109, and amended December 25, 1993, has promulgated safe drinking water standards for municipal water systems. Although

TABLE 6-7

SUMMARY OF DOSE-RESPONSE PARAMETERS
CHEMICALS OF CONCERN - AREA C GROUNDWATER
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Oral Exposure Route		Inhalation Exposure Route		GI Absorption Fraction[3]	Dermal Exposure Route		U.S. EPA Weight of Evidence
	Reference Dose[1]	Cancer Slope Factor[2]	Reference Dose	Cancer Slope Factor		Reference Dose	Cancer Slope Factor	
Acetone	1×10^{-1}	NA	NA	NA	1.00	1×10^{-1}	NA	D
Toluene	2×10^{-1}	NA	1×10^{-1}	NA	1.00	2×10^{-1}	NA	D
Tetrachloroethene	1×10^{-2}	5.2×10^{-2}	NA	2.0×10^{-3}	1.00	1×10^{-2}	5.2×10^{-2}	NA
Diethylphthalate	8×10^{-1}	NA	NA	NA	0.50	1.6×10^{0}	NA	D
Di-n-butylphthalate	1×10^{-1}	NA	NA	NA	0.90	1.1×10^{-1}	NA	D
Endosulfan II	5×10^{-5}	NA	NA	NA	0.50	1×10^{-4}	NA	NA
Antimony	4×10^{-4}	NA	NA	NA	0.05	8×10^{-3}	NA	D
Arsenic	3×10^{-4}	1.8×10^{0}	NA	1.5×10^{1}	0.95	3.2×10^{-4}	1.7×10^{0}	A
Barium	7×10^{-2}	NA	1×10^{-4}	NA	0.04	1.8×10^{0}	NA	D
Beryllium	5×10^{-3}	4.3×10^{0}	NA	8.4×10^{0}	0.02	2.5×10^{-1}	8.6×10^{-2}	B2
Cadmium	5×10^{-4}	NA	NA	6.3×10^{0}	0.02	2.5×10^{-2}	NA	B1
Chromium	5×10^{-3}(hex)	NA	NA	4.2×10^{1}	0.02	2.5×10^{-1}	NA	A (hex)
Cobalt	8×10^{-3}	NA	NA	NA	0.60	1.3×10^{-2}	NA	NA

TABLE 6-7 (Continued)
SUMMARY OF DOSE-RESPONSE PARAMETERS
CHEMICALS OF CONCERN - AREA C GROUNDWATER
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Oral Exposure Route		Inhalation Exposure Route		GI Absorption Fraction[3]	Dermal Exposure Route		U.S. EPA Weight of Evidence
	Reference Dose[1]	Cancer Slope Factor[2]	Reference Dose	Cancer Slope Factor		Reference Dose	Cancer Slope Factor	
Copper	4×10^{-2}	NA	NA	NA	0.50	8×10^{-2}	NA	D
Manganese	1.4×10^{-1}	NA	1×10^{-5}	NA	0.03	4.7×10^{0}	NA	D
Mercury	3×10^{-4}	NA	9×10^{-5}	NA	0.07	4.3×10^{-3}	NA	D
Thallium	8×10^{-5}	NA	NA	NA	0.05	1.6×10^{-3}	NA	D
Vanadium	7×10^{-3}	NA	NA	NA	0.01	7×10^{-1}	NA	D
Zinc	3×10^{-1}	NA	NA	NA	0.25	1.2×10^{0}	NA	D

NA Data not available for this chemical and/or exposure route.

(1) Reference doses presented in units of mg/Kg-day.
(2) Cancer slope factors presented in units of Kg-day/mg.
(3) Data obtained from chemical toxicological profiles, U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry.

these regulations do not apply to groundwater not currently used for drinking purposes on the Base, it is appropriate to compare detected concentrations of regulated chemicals to these standards as the groundwater is used by off-Base residents. Essentially the Pennsylvania standards have parity with the Federal primary and secondary MCLs, however, sufficient latitude has been incorporated into the law to allow the Commonwealth to adopt standards for individual chemicals which are numerically lower than respective Federal standards.

6.3.2.3 Maximum Contaminant Level Goals (MCLGs)

MCLGs are generally specified as zero for carcinogenic chemicals, based on the assumption of nonthreshold toxicity, and do not consider either the technical or economic feasibility of achieving these goals. MCLGs are nonenforceable guidelines based entirely on health effects. The MCLs are set as close to the MCLGs as is considered technically and economically feasible.

6.3.2.4 Health Advisories

Health Advisories are guidelines developed by the EPA Office of Drinking Water for nonregulated contaminants in drinking water. These guidelines are designed to consider both acute and chronic toxic effects in children (with an assumed body weight of 10 Kg) who consume 1 liter of water per day, or in adults (with an assumed body weight of 70 Kg) who consume 2 liters of water per day. Health Advisories are generally available for acute (1-day), subchronic (10-day), and chronic (longer-term or lifetime) exposure scenarios. These guidelines are designed to consider only threshold effects and, as such, are not used to set acceptable levels of known or probable human carcinogens.

6.3.3 Toxicity Profiles

The toxicity profiles that follow are prepared for the chemicals identified as the primary risk drivers at the conclusion of the risk assessment. Although not intended to be comprehensive evaluations of the pharmacological behavior of the chemicals in humans, the profiles provide rationale for the determination of the toxicological information used in the risk assessment and also identify toxic endpoints.

6.3.3.1 Antimony

Pharmacokinetics. Ingested antimony is absorbed slowly and incompletely from the gastrointestinal (GI) tract (Iffland, 1988). Within a few days of acute exposure, highest tissue concentrations are found in the liver, kidney, and thyroid. Organs of storage include skin, bone, and teeth. Highest concentrations in

deceased smelter workers (inhalation exposure) occurred in the lungs and skeleton. Excretion is largely via the urine or feces, although some is incorporated into the hair.

Noncancer Toxicity. Acute intoxication from ingestion of large doses of antimony induces GI disturbances, dehydration, and cardiac effects in humans (Iffland 1988). Chronic effects from occupational exposure include irritation of the respiratory tract, pneumoconiosis, pustular eruptions of the skin called "antimony spots," allergic contact dermatitis, and cardiac effects, including abnormalities of the electrocardiograph (ECG) and myocardial changes. Cardiac effects were also observed in rats and rabbits exposed by inhalation for six weeks and in animals (dogs, and possibly other species) treated by intravenous injection (Elinder and Friberg, 1986).

Chronic oral exposure studies in laboratory animals include two briefly reported lifetime drinking water studies in rats and mice (Kanisawa and Schroeder, 1969; Schroeder et al., 1970). The only dose tested, 5 ppm potassium antimony tartrate, resulted in reduced longevity in both species and in reduced mean heart weight in the rats. The EPA verified an RfD of 0.0004 mg/kg-day for chronic oral exposure to antimony from the LOAEL of 5 ppm potassium antimony tartrate (0.35 mg antimony/kg body weight-day) in the lifetime study in rats (Schroeder et al., 1970). An uncertainty factor of 1000 was applied; factors of 10 each for inter- and intra-species variation and to estimate an NOAEL from an LOAEL. The heart is considered a likely target organ for chronic oral exposure of humans.

Carcinogenicity. Data were not located regarding the carcinogenicity of antimony to humans. Antimony fed to rats did not produce an excess of tumors (Goyer, 1991), but a high frequency of lung tumors was observed in rats exposed by inhalation to antimony trioxide for one year (Elinder and Friberg, 1986). Antimony is classified in EPA cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans).

6.3.3.2 Arsenic

Pharmacokinetics. Several studies confirm that soluble inorganic arsenic compounds and organic arsenic compounds are almost completely (>90 percent) absorbed from the GI tract in both animals and humans (Ishinishi et al., 1986). The absorption efficiency of insoluble inorganic arsenic compounds depends on particle size and stomach pH. Initial distribution of absorbed arsenic is to the liver, kidneys, and lungs, followed by redistribution to hair, nails, teeth, bone, and skin, which are considered tissues of accumulation. Arsenic has a longer half-life in the blood of rats, compared with other animals and humans, because of firm binding to the hemoglobin in erythrocytes.

Metabolism of inorganic arsenic includes reversible oxidation-reduction so that both arsenite (valence of 3) and arsenate (valence of 5) are present in the urine of animals treated with arsenic of either valence (Ishinishi et al., 1986). Arsenite is subsequently oxidized and methylated by a saturable mechanism to form mono- or dimethyl-arsenate; the latter is the predominant metabolite in the urine of animals or humans. Organic arsenic compounds (arsenilic acid, cacodylic acid) are not readily converted to inorganic arsenic. Excretion of organic or inorganic arsenic is largely via the urine, but considerable species variation exists. Continuously exposed humans appear to excrete 60 to 70 percent of their daily intake of arsenate or arsenite via the urine.

Noncancer Toxicity. A lethal dose of arsenic trioxide in humans is 70 to 180 mg (approximately 50 to 140 mg arsenic; Ishinishi et al., 1986). Acute oral exposure of humans to high doses of arsenic produce liver swelling, skin lesions, disturbed heart function, and neurological effects. The only noncancer effects in humans clearly attributable to chronic oral exposure to arsenic are dermal hyperpigmentation and keratosis, as revealed by studies of several hundred Chinese exposed to naturally-occurring arsenic in well water (Tseng, 1977; Tseng et al., 1968; EPA, 1994). Similar effects were observed in persons exposed to high levels of arsenic in water in Utah and the northern part of Mexico (Cebrian et al., 1983; Southwick et al., 1983). Occupational (predominantly inhalation) exposure is also associated with neurological deficits, anemia, and cardiovascular effects (Ishinishi et al., 1986), but concomitant exposure to other chemicals cannot be ruled out. The EPA derived an RfD of 0.3 μg/kg/day for chronic oral exposure, based on an NOAEL of 0.8 μg/kg/day for skin lesions from the Chinese data. The principal target organ for arsenic appears to be the skin. The nervous system and cardiovascular systems appear to be less significant target organs. Inorganic arsenic may be an essential nutrient, exerting beneficial effects on growth, health, and feed conversion efficiency (Underwood, 1977).

Carcinogenicity. Inorganic arsenic is clearly a carcinogen in humans. Inhalation exposure is associated with increased risk of lung cancer in persons employed as smelter workers, in arsenical pesticide applicators, and in a population residing near a pesticide manufacturing plant. Oral exposure to high levels in well water is associated with increased risk of skin cancer (Tseng, 1977; EPA, 1994). Extensive animal testing with various forms of arsenic given by many routes of exposure to several species, however, has not demonstrated the carcinogenicity of arsenic (International Agency for Research on Cancer [IARC] 1980). The EPA classifies inorganic arsenic in cancer weight-of-evidence Group A (human carcinogen), and recommends an oral unit risk of 0.00005 μg/L in drinking water, based on the incidence of skin cancer in the Tseng (1977) study. The EPA notes that the uncertainties associated with the oral unit risk are considerably less than those for most carcinogens, so that the unit risk might be reduced an order of

magnitude. An inhalation unit risk of 0.0043 per $\mu g/m^3$ was derived for inorganic arsenic from the incidence of lung cancer in occupationally exposed men.

6.3.3.3 Manganese

Noncancer Toxicity. Manganese is nutritionally required in humans for normal growth and health. Humans exposed to approximately 0.8 mg manganese/kg/day in drinking water exhibited lethargy, mental disturbances (1/16 committed suicide), and other neurologic effects. The elderly appeared to be more sensitive than children. Oral treatment of laboratory rodents induced biochemical changes in the brain, but rodents did not exhibit the neurological signs exhibited by humans. Occupational exposure to high concentrations in air induced a generally typical spectrum of neurological effects, and increased incidence of pneumonia (ACGIH, 1986).

Very recently, a chronic oral RfD of 0.005 mg/kg-day has been made available for manganese (EPA, 1994). The subchronic oral RfD presented by EPA was the same value as the chronic oral RfD. It seems prudent to remove the subchronic oral RfD as well, to reflect EPA's lack of confidence in this derivation. The EPA presented a verified chronic inhalation RfD of 0.00005 mg/m^3 based on an LOAEL for respiratory symptoms and psychomotor disturbances in occupationally exposed humans and an uncertainty factor of 1000. The EPA presented the same value as a subchronic inhalation RfC. The inhalation RfC is equivalent to 0.000014 mg/kg-day, assuming humans inhale 20 m^3 of air/day and weigh 70 kg. The CNS and respiratory tract are target organs of inhalation exposure to manganese.

Carcinogenicity. The EPA classifies manganese in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans). Quantitative cancer risk estimates are not derived for Group D chemicals.

6.3.3.4 Tetrachloroethene

Noncancer Toxicity. Occupational (inhalation and dermal) exposure to tetrachloroethene was associated with neurologic effects, beginning with incoordination and progressing to dizziness, headache, vertigo, and unconsciousness (ACGIH, 1986). The EPA presented a verified chronic oral RfD for tetrachloroethene of 0.01 mg/kg-day based on an NOAEL for liver toxicity in mice in a subchronic gavage study, and on an NOEL for depressed body weight gain in rats in a subchronic drinking water study. An uncertainty factor of 1000 was used. The EPA presented a provisional subchronic oral RfD of 0.1 mg/kg-day based on the same NOEL and an uncertainty factor of 100. The CNS is the principal target organ for inhalation exposure and the liver is the principal target organ for oral exposure to tetrachloroethene.

Carcinogenicity. Inhalation exposure to tetrachloroethene induced mononuclear cell leukemia in rats, and inhalation or oral exposure induced hepatocellular carcinomas in mice (ATSDR, 1988). Occupational exposure data do not suggest a carcinogenic role for tetrachloroethene in humans (ACGIH, 1986). Interpretation of the data regarding the carcinogenicity of tetrachloroethene is controversial, and the EPA has not adopted a final position on the cancer weight-of-evidence classification or quantitative risk estimates for tetrachloroethene. For this reason, the cancer evaluation of tetrachloroethene was removed from the 1992 HEAST.

6.3.3.5 Thallium, Soluble Salts

Noncancer Toxicity. Thallium is highly toxic; acute ingestion by humans or laboratory animals induced gastroenteritis, neurological dysfunction, and renal and liver damage (Kazantzis, 1986). Chronic ingestion of more moderate doses characteristically caused alopecia. Thallium was used medicinally to induce alopecia in cases of ringworm of the scalp, sometimes with disastrous results. In industrial (inhalation, oral, dermal) exposure, neurologic signs preceded alopecia, suggesting that the nervous system is more sensitive than the hair follicle. The EPA presented verified chronic oral RfD values for several thallium salts (thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, and thallium sulfate) based on increased incidence of alopecia and increased serum levels of liver enzymes indicative of hepatocellular damage in rats treated with thallium sulfate for 90 days. An oral RfD for thallium alone, however, was not located. Target organs for thallium include the GI tract (acute exposure), nervous system, skin, kidney, and liver.

Carcinogenicity. Several thallium compounds (thallium oxide, thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, thallium sulfate) were classified as cancer weight-of-evidence Group D substances (not classifiable as to carcinogenicity to humans). No weight-of-evidence classification was located for thallium alone.

6.3.4 Summary

Tables 6-7 and 6-8 present the available dose-response parameters and Federal ARARs and TBCs, respectively, for both carcinogenic and noncarcinogenic chemicals of concern. All available toxicity information is included in this table. If the intake of a chemical exceeds these standards or guidelines, there is a possibility that a receptor may experience adverse health effects. Expected intakes of each chemical were presented in the Exposure Assessment (Section 6.2).

TABLE 6-8

SUMMARY OF ARARs AND TBC VALUES
CHEMICALS OF CONCERN - AREA C GROUNDWATER
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Safe Drinking Water Act (mg/L)[1]		Pennsylvania Groundwater Quality Standard (mg/L)[2]	Health Advisory (mg/L)[1]
	MCL	MCLG		
Acetone	NA	NA	NA	NA
Toluene	1	1	1	1-day/Child: 20 10-day/Child: 2 Longer-term/Child: 2 Longer-term/Adult: 7 Lifetime/Adult:1
Tetrachloroethene	0.005	0	0.005	1-day/Child: 2 10-day/Child: 2 Longer-term/Child: 1 Longer-term/Adult: 5
Diethylphthalate	NA	NA	NA	Lifetime/Adult: 5
Di-n-butylphthalate	NA	NA	NA	NA
Endosulfan II	NA	NA	NA	NA
Aluminum	0.05 - 2[4]	NA	0.05 - 2[4]	NA
Antimony	0.006	0.006	0.006	1-day/Child: 0.01 10-day/Child: 0.01 Longer-term/Child: 0.01 Longer-term/Adult: 0.015 Lifetime/Adult: 0.003
Arsenic	0.05	NA	0.05	NA
Barium	2	2	2	Lifetime/Adult: 2
Beryllium	0.004	0.004	0.004	1-day/Child: 30 10-day/Child: 30 Longer-term/Child: 4 Longer-term/Adult: 20
Cadmium	0.005	0.005	0.005	1-day/Child: 0.04 10-day/Child: 0.04 Longer-term/Child: 0.005 Longer-term/Adult: 0.02 Lifetime/Adult: 0.005
Chromium (total)	0.1	0.1	0.1	1-day/Child: 1 10-day/Child: 1 Longer-term/Child: 0.2 Longer-term/Adult: 0.8 Lifetime/Adult: 0.1

TABLE 6-8 (Continued)
SUMMARY OF ARARs AND TBC VALUES
CHEMICALS OF CONCERN - AREA C GROUNDWATER
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Safe Drinking Water Act (mg/L)[1]		Pennsylvania Groundwater Quality Standard (mg/L)[2]	Health Advisory (mg/L)[1]
	MCL	MCLG		
Cobalt	NA	NA	NA	NA
Copper	1.3[3]	1.3	1.3	NA
Iron	0.3[4]	NA	0.3[4]	NA
Lead	0.015[3]	0	0.015[3]	NA
Manganese	0.05[4]	NA	0.05[4]	NA
Mercury	0.002	0.002	0.002	Longer-term/Adult: 0.002 Lifetime/Adult: 0.002
Thallium	0.002	0.0005	0.002	1-day/Child: 0.007 10-day/Child: 0.007 Longer-term/Child: 0.007 Longer-term/Adult: 0.02 Lifetime/Adult: 0.0004
Vanadium	NA	NA	NA	NA
Zinc	5[4]	NA	5[4]	1-day/Child: 6 10-day/Child: 6 Longer-term/Child: 3 Longer-term/Adult: 12 Lifetime/Adult: 2

NA Standard not available for this chemical.

(1) Safe Drinking Water Act, 40 CFR 141-143.
(2) Pennsylvania Drinking Water Regulations, Pennsylvania Code, Title 25, Chapter 109, December 25, 1993.
(3) Action Level.
(4) Secondary MCL value.

6.4 RISK CHARACTERIZATION

Potential human health risks resulting from the exposures outlined in the preceding section are characterized on a quantitative and qualitative bases in this section. Quantitative risk estimates are generated based on risk assessment methods outlined in current U.S. EPA guidance (U.S. EPA, December 1989), and the qualitative assessment consists of a comparison of measured concentrations to standards or guidelines.

Noncarcinogenic risk estimates are presented in the form of Hazard Quotients and Hazard Indices that are determined through comparison of estimated intakes with published Reference Doses. Incremental cancer risk estimates are provided in the form of dimensionless probabilities based on Cancer Slope Factors.

Estimated human intakes were developed for each of the specific exposure routes discussed in the preceding sections. Both carcinogenic and noncarcinogenic risks are summarized for each exposure route on a series of tables in this section. Detailed calculations are provided in Appendix D.

Noncarcinogenic risk is assessed using the concept of Hazard Quotients and Hazard Indices. The Hazard Quotient for a selected chemical of concern is the ratio of the estimated intake and the Reference Dose (RfD) and is calculated as follows:

$$\textit{Hazard Quotient (HQ)} = \frac{\textit{Dose}}{\textit{RfD}}$$

A Hazard Index is generated by summing the individual Hazard Quotients for the chemicals of concern. If the value of the Hazard Index exceeds unity (1.0), there is a potential noncarcinogenic health risk associated with exposure to that particular chemical mixture (U.S. EPA, September 24, 1986). At that time, particular attention should be paid to the target organs affected by each chemical. The Hazard Index is not a mathematical prediction of the severity of toxic effects; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects. If the ratio of the intake and the RfD for any individual chemical exceeds unity, toxic effects would also be expected.

Incremental cancer risk estimates are generated for each of the exposure pathways using the estimated intakes and published Cancer Slope Factors (CSFs), as follows:

$$\textit{Incremental Cancer Risk (ICR)} = \textit{Dose} \times \textit{CSF}$$

If the above equation results in a risk greater than 0.01, the following equation is used:

$$ICR = 1 - \exp^{(-Dose \times CSF)}$$

The risk determined using these equations is a unitless expression of an individual's likelihood of developing cancer as a result of exposure to carcinogenic chemicals. An incremental cancer risk of 1×10^{-6} indicates that the exposed receptor has a one in one million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons. The calculated cancer risks should be recognized as upper-limit estimates. Cancer Slope Factors are the upper 95 percent confidence limit of a dose-response curve generally derived from animal studies. Actual human risk, while not identifiable, is not expected to exceed the upper limit based on the CSFs, and, in fact, may be lower.

The U.S. EPA has generally defined risks in the range of 10^{-4} to 10^{-6} as being acceptable for most hazardous waste facilities addressed under CERCLA. For CERCLA activities, residual risks on the order of 10^{-6} are the primary goal, but are often modified by such regulatory requirements as MCLs or chemical-specific cleanup goals. Cancer risks are generally not calculated for small children because of the short (i.e., 6 years) exposure duration, unless no other receptors are being considered for an exposure route.

Carcinogenic and noncarcinogenic health risks are estimated using a number of different assumptions; therefore the values presented in this section contain an inherent amount of uncertainty. The extent to which health risks can be characterized is primarily dependent upon the accuracy with which the toxicity of a chemical can be estimated and the accuracy of the exposure scenario assumptions. The toxicologic data that form the basis for all risk assessments contain uncertainty in the following areas:

- The extrapolation of nonthreshold (carcinogenic) effects from the high doses administered to laboratory animals to the low doses received under more common human exposure scenarios.

- The extrapolation of the results of laboratory animal studies to human or environmental receptors.

- The interspecies variation in toxicological endpoints used in characterizing potential health effects resulting from exposure to a chemical.

- The variations in sensitivity among individuals of any particular species.

In addition to these sources of uncertainty, the exposure estimates presented in Section 6.3 are also based on a number of simplifying assumptions. The assumptions made include the following:

- Receptor characteristics, such as age, body weight, and exposure duration, are based on published values, with some attempt at making them more site-specific.

- Land use and activity patterns in the area are limited to the observations made during the field investigation and known land uses in the surrounding area.

- There are no antagonistic or synergistic effects between the chemicals of concern.

The chemical analytical data base also has some limitations in such areas as sample number and location, and the representativeness of the laboratory results. However, every effort was made to collect samples that reflect actual site conditions.

Chemical-specific Hazard Quotients and Incremental Cancer Risks for exposures to contaminated groundwater are presented in Tables 6-9 through 6-15.

6.4.1 Human Health Risks

The results of the quantitative risk assessment provide a measure of the potential for occurrence of adverse health effects (carcinogenic and/or noncarcinogenic) in the receptors which are evaluated. For Area C groundwater exposures, two receptor groups are examined: currently exposed offsite residents and residents which may be exposed to groundwater if the sites are developed as a residential community. The discussion that follows presents the conclusions for the risk assessment.

6.4.1.1 Current Off-Base Residents

Residential groundwater well sampling has resulted in a pool of data for groundwater which has been used in the quantitative risk assessment. Although only analyzed for volatile organic constituents, the conclusions of the risk assessment are considered to be valid, in light of the fact that significant nonvolatile chemical contamination is not believed to be site related. The only chemical detected in the residential groundwater wells was tetrachloroethene. Risks associated with current groundwater exposure are presented in Table 6-9. The risk ranges represent risks associated with exposure to the maximum (31 μg/L) and minimum (0.3 μg/L) detected concentrations of tetrachloroethene.

TABLE 6-9

RISK CHARACTERIZATION SUMMARY - PCE EXPOSURE
CURRENT OFFSITE RESIDENTS
NAWC WARMINSTER, PENNSYLVANIA

Receptor		Hazard Index				Incremental Cancer Risk			
		Incidental Ingestion	Dermal Contact	Inhalation of Volatiles	Total	Incidental Ingestion	Dermal Contact	Inhalation of Volatiles	Total
Adult Resident	max[1]	8.5E-2	NA	3.2E-2	1.3E-1	1.9E-5	NA	2.7E-7	1.9E-5
	min[2]	6.9E-9	NA	2.6E-4	1.1E-3	1.5E-7	NA	2.2E-9	1.5E-7
Child Resident	max	2.0E-1	1.7E-2	NA	2.2E-1	8.8E-6	7.7E-7	NA	9.6E-6
	min	1.6E-3	1.4E-4	NA	1.8E-3	7.1E-8	6.2E-9	NA	7.8E-8

(1) Risks based on maximum detected tetrachloroethene concentration of 31 μg/L.
(2) Risks based on minimum detected tetrachloroethene concentration of 0.3 μg/L.

TABLE 6-10

SUMMARY OF CALCULATED RISKS - AREA C GROUNDWATER
FUTURE ADULT RESIDENT
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Adult Resident					
	Incidental Ingestion		Dermal Contact		Inhalation of Volatiles	
	Non-Carc.[1]	Carc.[2]	Non-Carc.	Carc.	Non-Carc.	Carc.
Tetrachloroethene	1.4E-2	3.1E-6	NA	NA	NA	4.4E-8
Antimony	1.3E0	NA	NA	NA	NA	NA
Arsenic	3.7E-1	8.7E-5	NA	NA	NA	NA
Barium	1.3E-1	NA	NA	NA	NA	NA
Beryllium	3.6E-3	3.3E-5	NA	NA	NA	NA
Cadmium	1.3E-1	NA	NA	NA	NA	NA
Chromium	3.6E-2	NA	NA	NA	NA	NA
Cobalt	1.3E-2	NA	NA	NA	NA	NA
Copper	1.1E-2	NA	NA	NA	NA	NA
Manganese	8.8E0	NA	NA	NA	NA	NA
Thallium	7.5E-1	NA	NA	NA	NA	NA
Vanadium	2.2E-2	NA	NA	NA	NA	NA
Zinc	2.1E-2	NA	NA	NA	NA	NA
TOTAL:	**1.16E+1**	**1.2E-4**	**NA**	**NA**	**NA**	**4.4E-8**

NA Risk estimate not available, exposure route and/or chemical not applicable.

1 Noncarcinogenic risk estimate (hazard quotient).
2 Carcinogenic risk estimate.

TABLE 6-11

SUMMARY OF CALCULATED RISKS - AREA C GROUNDWATER
FUTURE CHILD RESIDENT
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Child Resident					
	Incidental Ingestion		Dermal Contact		Inhalation of Volatiles	
	Non-Carc.[1]	Carc.[2]	Non-Carc.	Carc.	Non-Carc.	Carc.
Tetrachloroethene	3.2E-2	1.4E-6	2.8E-3	1.2E-7	NA	NA
Antimony	3.0E0	NA	2.8E-4	NA	NA	NA
Arsenic	8.7E-1	4.0E-5	1.5E-3	7.0E-8	NA	NA
Barium	3.0E-1	NA	2.2E-5	NA	NA	NA
Beryllium	8.4E-3	1.6E-5	3.1E-9	5.7E-10	NA	NA
Cadmium	3.1E-1	NA	1.1E-5	NA	NA	NA
Chromium	8.4E-2	NA	3.1E-6	NA	NA	NA
Cobalt	3.0E-2	NA	3.2E-5	NA	NA	NA
Copper	2.5E-2	NA	2.3E-5	NA	NA	NA
Manganese	2.0E+1	NA	4.0E-5	NA	NA	NA
Thallium	1.8E0	NA	1.6E-4	NA	NA	NA
Vanadium	5.1E-2	NA	9.3E-7	NA	NA	NA
Zinc	4.8E-2	NA	2.2E-5	NA	NA	NA
TOTAL:	**2.70E+1**	**5.7E-5**	**4.9E-3**	**1.9E-7**	**NA**	**NA**

NA Risk estimate not available, exposure route and/or chemical not applicable.

1 Noncarcinogenic risk estimate (hazard quotient).
2 Carcinogenic risk estimate.

TABLE 6-12

RISK CHARACTERIZATION SUMMARY - AREA C GROUNDWATER
FUTURE RESIDENTS
NAWC WARMINSTER, PENNSYLVANIA

Receptor	Hazard Index				Incremental Cancer Risk			
	Ingestion	Dermal Contact	Inhalation of Volatiles	Total Hazard Index	Ingestion	Dermal Contact	Inhalation of Volatiles	Total Cancer Risk
Future Resident (Adult)	11.6	NA	NA	11.6	1.2E-4	NA	4.4E-8	1.2E-4
Future Resident (Child)	27.0	4.9E-3	NA	27.0	5.7E-5	1.9E-7	NA	5.7E-5

TABLE 6-13

SUMMARY OF CALCULATED RISKS - SITE 4 GROUNDWATER
FUTURE ADULT RESIDENT
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Adult Resident					
	Incidental Ingestion		Dermal Contact		Inhalation of Volatiles	
	Non-Carc.[1]	Carc.[2]	Non-Carc.	Carc.	Non-Carc.	Carc.
Antimony	1.4E0	NA	NA	NA	NA	NA
Arsenic	3.7E-1	8.7E-5	NA	NA	NA	NA
Barium	1.8E-1	NA	NA	NA	NA	NA
Cadmium	1.4E-1	NA	NA	NA	NA	NA
Chromium	3.8E-2	NA	NA	NA	NA	NA
Copper	2.0E-2	NA	NA	NA	NA	NA
Manganese	1.0E+1	NA	NA	NA	NA	NA
Thallium	8.2E-1	NA	NA	NA	NA	NA
Vanadium	4.3E-2	NA	NA	NA	NA	NA
Zinc	2.1E-2	NA	NA	NA	NA	NA
TOTAL:	**1.31E+1**	**8.7E-5**	**NA**	**NA**	**NA**	**NA**

NA Risk estimate not available, exposure route and/or chemical not applicable.

1 Noncarcinogenic risk estimate (hazard quotient).
2 Carcinogenic risk estimate.

TABLE 6-14

SUMMARY OF CALCULATED RISKS - SITE 4 GROUNDWATER
FUTURE CHILD RESIDENT
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Child Resident					
	Incidental Ingestion		Dermal Contact		Inhalation of Volatiles	
	Non-Carc.[1]	Carc.[2]	Non-Carc.	Carc.	Non-Carc.	Carc.
Antimony	3.3E-0	NA	3.0E-4	NA	NA	NA
Arsenic	8.7E-1	4.0E-5	1.5E-3	7.0E-8	NA	NA
Barium	4.2E-1	NA	3.0E-5	NA	NA	NA
Cadmium	3.2E-1	NA	1.2E-5	NA	NA	NA
Chromium	9.0E-2	NA	3.3E-6	NA	NA	NA
Copper	4.6E-2	NA	4.2E-5	NA	NA	NA
Manganese	2.4E-1	NA	4.6E-5	NA	NA	NA
Thallium	1.9E-0	NA	1.8E-4	NA	NA	NA
Vanadium	9.9E-2	NA	1.8E-6	NA	NA	NA
Zinc	4.8E-2	NA	2.2E-5	NA	NA	NA
TOTAL:	**3.07E-1**	**4.0E-5**	**2.2E-3**	**7.0E-8**	**NA**	**NA**

NA Dose estimate not available, metals assumed to be nonvolatile.

1 Noncarcinogenic risk estimate.
2 Carcinogenic risk estimate.

TABLE 6-15

RISK CHARACTERIZATION SUMMARY - SITE 4 GROUNDWATER
FUTURE RESIDENTS
NAWC WARMINSTER, PENNSYLVANIA

Receptor	Hazard Index				Incremental Cancer Risk			
	Ingestion	Dermal Contact	Inhalation of Volatiles	Total Hazard Index	Ingestion	Dermal Contact	Inhalation of Volatiles	Total Cancer Risk
Future Resident (Adult)	13.1	NA	NA	13.1	8.7E-5	NA	NA	8.7E-5
Future Resident (Child)	30.7	2.2E-3	NA	30.7	4.0E-5	7.0E-8	NA	4.0E-5

The noncarcinogenic (systemic) risks posed by adult residential exposure to tetrachloroethene in the groundwater are minimal, as evidenced by a calculated hazard index of approximately 0.13. The child receptor experiences a hazard index of about 0.22. Since the hazard indices are less than a value of one for both receptors, adverse systemic health effects are not excepted.

Carcinogenic risks for the off-Base user of residential groundwater are quantified for the adult and child receptors. The total incremental cancer risk due to ingestion, dermal contact, and inhalational exposures to groundwater ranges from 1.5×10^{-7} to 1.9×10^{-5}. This result corresponds to one cancer incidence due to the groundwater use in an exposed population of about 52,600 receptors. The result exceeds the U.S. EPA lower risk range goal of 10^{-6}, however, it does not exceed the upper goal of 10^{-4}, which acts as a trigger for necessitated remedial action. Cancer risks to child receptors ranges from 7.8×10^{-8} to 9.6×10^{-6}, the upper-bound risk corresponding to one cancer incidence per population of 100,000.

The principal detected contaminant within Area C, tetrachloroethene, does not pose a cancer risk which exceeds 10^{-4}. The use of the range of detected concentrations also indicates that most cancer risks are lower than at the worst-case location, where tetrachloroethene levels are at the maximum value (31 μg/L). Although metallic constituents can contribute significant amounts to the risks, groundwater data from the monitoring wells located within the boundaries of NAWC Warminster indicate there to be significant background levels of metallic chemicals at Area C near Site 8.

6.4.1.2 Future Residents (Area C Groundwater)

The use of Area C data provides an estimate of future offsite risks, assuming that all contaminants transport at the same rates. In the evaluation of the risks for future residents near Area C, the 95% UCL concentration of detected chemicals from unfiltered samples were used to assess risk.

Noncarcinogenic effects, predicted by a hazard index which exceeds a value of one, can be expected for adult and child residential receptors. A Hazard Index of 13.0 is noted for the adult and 27.0 for the child. For both receptors, the ingestion exposure route provides almost all of the risk.

Child receptors, due primarily to their low body weight, are the most sensitive receptor. Individual Hazard Indices exceeded a value of one for manganese (20.5), antimony (3.0), and thallium (1.8). Toxic effects which may be exhibited include dermal and cardiac effects (antimony), CNS effects (manganese and thallium), and renal and liver damage (thallium).

Cancer risks to children, 5.7×10^{-5}, are noted to be primarily due to arsenic (4.0×10^{-5}), beryllium (1.6×10^{-5}), and tetrachloroethene (1.4×10^{-6}). Again, the ingestion exposure route provides a significant portion of the risk (>99%) when compared to dermal risks.

Although it may appear that metallic contaminants are driving the risks, it should be noted that many of the constituents detected are naturally occurring and, at the levels detected, may be within background concentrations. For example, comparison of the 95% UCL concentrations in Table 6-1 with the 95% UCL concentrations in Tables 6-2 and 6-3, indicates representative concentrations used for arsenic and beryllium are lower in Area C wells than for background. A more comprehensive background groundwater quality study performed for the Phase II RI investigation at NAWC Warminster (Halliburton NUS, 1992) indicates a background manganese concentration of 2,200 μg/L, which is also higher than the Area C representative concentration. Thallium and antimony were detected in unfiltered samples in only one well (HN-29I), a deep-screened well (122 to 130 feet BGS) which is not likely to have been impacted to a greater extent than shallow, near downgradient wells at Site 4 which did not contain antimony or thallium. Antimony was detected in filtered samples from 13 wells, however, the background 95% UCL for the filtered samples (44.7 μg/L) exceeded the 95% UCLs for both the Area C in total and Site 4 downgradient well groupings (35.0 μg/L) and 37.8 μg/L, respectively) (Tables 6-1, 6-2, and 6-3), indicating that the antimony appears to be naturally occurring and not site related.

Adult residents who are exposed to groundwater in the manner evaluated can also expect adverse systemic effects due to groundwater chemical exposure. Exposure to groundwater results in a Hazard Index of 11.6. The chemicals which contribute the greatest amount to the risks are identical to those which pose risk to children, however, the greater body weight of the adult receptor decreases the impact of the total body dose. Total metals hazard indices for arsenic and manganese exceed unity. Cumulative effects from lesser contributors to the risk (thallium, chromium, and arsenic) are not likely to provide antagonistic effects, as the chemicals have varied toxic endpoints.

Carcinogenic risks to the adult residential receptors using groundwater from Area C exceeds the CERCLA upper risk range goal of 10^{-4} for receptors exposed to filtered or unfiltered groundwater. As with the child, arsenic and beryllium are the primary risk contributors, providing over 95 percent of the risk. The incremental cancer risk associated with residential use of unfiltered groundwater is approximately 1.2×10^{-4}, which corresponds to one cancer incidence per an exposed population of about 8,300 individuals. Without exception, the ingestion exposure route is the primary route of cancer risk contribution. Inhalation of volatiles is the least significant of the exposure routes, providing risk contribution on the order of 4.4×10^{-8}

to the total risk. As mentioned previously, strong evidence suggests a large portion of these risks can be attributed to background.

Tables 6-10 and 6-11 present a summary of the noncarcinogenic and carcinogenic risks for the residential receptors exposed to Area C groundwater under the future residential exposure scenario. Table 6-12 presents a summary of the potential future Area C groundwater risks.

6.4.1.3 Site 4

The risk assessment for Site 4 groundwater was performed using the unfiltered sample data from downgradient monitoring wells DG-4, DG-5, DG-8, DG-15, DG-16, DG-22, DG-24, DG-28, HN-292, HN-29I, and HN-29X. Representative concentrations were screened against background and U.S. EPA Region III screening values to identify potential chemicals of concern.

The results of the assessment closely reflect conclusions obtained for the Area C groundwater, although no tetrachloroethene is present in Site 4 downgradient wells. Child residential receptors experience a total HI of 30.7, due primarily to antimony, manganese, and thallium. An incremental cancer risk of 4.0×10^{-5} is also noted, but is solely attributable to arsenic. As discussed for Area C, the risks presented by arsenic, manganese, and antimony are believed to be attributable to background, as these respective representative concentrations are less than the calculated background levels. Thallium was detected in only one unfiltered sample and is not believed to be a site-related contaminant.

Adult receptors exposed to Site 4 downgradient groundwater can also be expected to experience adverse systemic health effects indicated by a Hazard Index of 13.1. The risk is driven by manganese (10) and antimony (1.4). The cancer risk increase, 8.7×10^{-5}, is attributable to arsenic only. Inhalation exposures were not able to be quantified as metallic constituents are assumed to be nonvolatiles. Tables 6-13 through 6-15 summarize risks for receptors at Site 4.

6.4.2 ARARs Comparison

Positively detected chemicals in the groundwater from Area C, associated groundwater standards, and frequency of exceedence of the standards is presented in Table 6-16. As demonstrated in the table, the standards for tetrachloroethene (4/10), aluminum (28/30), iron (18/23), manganese (21/31), and thallium (1/1) are exceeded for unfiltered samples. Exceedences are also noted for aluminum (1/1), antimony (12/12), cadmium (1/2), iron (5/13), lead (1/2), and manganese (15/28) in the filtered samples.

TABLE 6-16

GROUNDWATER STANDARD EXCEEDENCE SUMMARY
AREA C GROUNDWATER
NAWC WARMINSTER, PENNSYLVANIA

Chemical	Applicable Standard (mg/L)	Unfiltered Samples		Filtered Samples	
		Frequency of Detection	Frequency of Exceedence	Frequency of Detection	Frequency of Exceedence
Acetone	NA	9/24	0/9	NA	NA
Toluene	1	2/34	0/2	NA	NA
Tetrachloroethene	0.005	10/34	4/10	NA	NA
Diethylphthalate	NA	1/22	0/1	NA	NA
Di-n-butylphthalate	NA	4/22	0/4	NA	NA
Endosulfan II	NA	1/22	0/1	NA	NA
Aluminum	0.05 - 2	30/34	28/30	1/34	1/1
Antimony	0.006	1/34	1/1	12/34	12/12
Arsenic	0.05	17/34	0/17	4/34	0/4
Barium	2	34/34	0/34	34/34	0/34
Beryllium	0.004	4/34	0/4	2/34	0/2
Cadmium	0.005	8/34	2/8	2/34	1/2
Chromium	0.1	4/34	0/4	0/34	0/0
Cobalt	NA	2/34	0/2	0/34	0/0
Copper	1.3	21/34	0/21	11/34	0/11
Iron	0.3	23/34	18/23	13/34	5/13
Lead	0.015	12/34	0/12	2/34	1/2
Manganese	0.05	31/34	21/31	28/34	15/28
Mercury	0.002	5/34	0/5	1/34	0/1
Thallium	0.002	1/34	1/1	0/34	0/0
Vanadium	NA	2/34	0/2	2/34	0/2
Zinc	5	13/34	0/13	23/34	0/23

NA *Standard not available.*

Positively detected calcium, magnesium, potassium, and sodium in groundwater for Area C deleted from table as no standards for these chemicals are available.

Chemicals whose standards are exceeded in both data groups (namely aluminum, iron, and manganese) are commonly encountered metals in groundwater. Standards for these chemicals are Secondary MCLs and are based on aesthetic water quality. Tetrachloroethene standard exceedences are noted for the wells located close to an undefined, suspected tetrachloroethene source area between Sites 4 and 8. The only other unfiltered metal result (thallium) that exceeded a respective standard was detected in only one groundwater sample and is not considered to be a site related contaminant.

In filtered groundwater samples, the occurrence of antimony, cadmium, and lead provide the most notable standard exceedences.

6.4.3 Summary

The results of the quantitative risk assessment demonstrate significant adverse systemic human health risks for the future residential users of the groundwater at Area C. Primary contaminants of concern include tetrachloroethene, antimony, arsenic, beryllium, manganese, and thallium. However, current off-Base groundwater use is expected to result in no adverse systemic health effects for the adult or child receptors, but a maximum increased cancer incidence of 1.9×10^{-5} for adults and 9.6×10^{-6} for children (Table 6-9). Antimony, arsenic, beryllium, and manganese concentrations appear to be background levels that are naturally occurring in the area.

The maximum cumulative cancer risk for groundwater exposure by current off-Base residents is calculated to be 1.9×10^{-5}, which corresponds to approximately one cancer incidence attributable to exposure for an exposed population of 50,000 individuals. Although this risk value exceeds the U.S. EPA lower risk range goal of 10^{-6}, the risk is less than the upper goal value of 10^{-4}, which is frequently used to trigger remedial activity.

An incremental cancer risk of 1.2×10^{-4} (Table 6-12) was calculated for future adult residents. This risk exceeds the upper risk range goal and corresponds to an approximated cancer incidence rate of one per 8,000 exposed residents. Child cancer risks are determined to be 5.7×10^{-5} (Table 6-12). Risks demonstrated for groundwater provide an indication of the need for remedial action.

Groundwater chemical data which exceeded Federal or Commonwealth of Pennsylvania safe drinking water standards generally support the conclusions of the risk assessment. Although no exceedences are noted for arsenic (the primary noncancer and carcinogenic risk contributor), primary MCL exceedences are noted for tetrachloroethene (in unfiltered samples) and antimony, cadmium, and lead (in filtered samples). Secondary MCL exceedences are noted for iron and manganese. Thallium, although exceeding the primary

MCL, was detected in only one unfiltered groundwater sample, and is not believed to be a site related contaminant.

6.5 CONCLUSIONS

6.5.1 Area C Overall

Tables 6-9 and 6-12 summarize the results of the risk assessment for Area C groundwater. The results of the quantitative risk assessment indicate the current residential users of groundwater incur a maximum incremental cancer risk of 1.9×10^{-5}, due to exposure to tetrachloroethene migrating from Area C. Although greater than the lower risk range goal of 10^{-6}, the risk is below the upper limit of 10^{-4}. The associated Hazard Index, a maximum of 0.13, is less than unity, and adverse system health effects are not anticipated. The current use of carbon polishing systems at affected residences certainly reduces risk levels that are calculated, as evidenced by MCL compliance which is demonstrated. Also, many of the residential wells will soon be unused, as a municipal water supply is currently being installed along Kirk Road.

Based on the analytical data from Area C monitoring wells, a future residential exposure scenario was also evaluated. Cumulative hazard indices of 11.6 and 27.0 were calculated for adult and child receptors, respectively. The major (greater than 1.0) contributors to the total hazard index are manganese and arsenic, and thallium also for the child. The representative concentrations used for the risk assessment for manganese and arsenic are less than determined background levels and are considered to be naturally occurring. Thallium is detected at only one sampling location and its status as a site-related contaminant above background cannot be confirmed without additional data.

Cancer risk levels of 1.2×10^{-4} and 5.7×10^{-5}, respectively, have been calculated for future adult and child residential exposure to Area C groundwater (Table 6-12). For both receptors, tetrachloroethene (3% of risk), arsenic (70% of risk), and beryllium (27% of risk) are the only risk drivers. Representative concentrations for arsenic and beryllium are less than respective background levels and are considered to be background.

6.5.1.1 Site 4

For the focused risk assessment of Site 4 groundwater, only the downgradient wells are considered. The groundwater does not contain detectable quantities of tetrachloroethene as with other wells of Area C, but notable amounts of metallic chemicals were detected in shallow wells (DG-4, DG-5, DG-15, and HN-29X). Due primarily to the data from these four wells, the calculated risks are above acceptable limits. Table 6-12 provides a summary of risks posed to future residential exposure to Site 4 downgradient groundwater.

Hazard indices for the adult and child residential receptors have been calculated to be 13.1 and 30.7, respectively, for both receptors. The most significant proportion of the risks are provided by manganese (77%), antimony (11%), and thallium (6%). For the child receptor, arsenic also provides a total hazard index of 0.88. Adverse health effects are not expected due to this chemical, but synergistic contributions are not accounted to specific target organs.

The representative concentrations used for arsenic and manganese are noted to be less than calculated background for these chemicals and the calculated risks are considered to be representative of natural levels. Antimony and thallium are detected in only one unfiltered sample each, both at levels less than twice respective detection limits. In filtered samples, antimony was detected in 13 wells, with comparable concentrations in both upgradient and downgradient wells. This indicates that antimony is probably naturally occurring at the concentrations detected.

Calculated cancer risks for Site 4 groundwater of 8.7×10^{-5} and 4.0×10^{-5} were obtained for adult and child residents, respectively (Table 6-15). Arsenic is the sole contributor to this risk, and is attributed to naturally-occurring levels of this chemical as previously discussed.

7.0 SUMMARY AND CONCLUSIONS

Based on the findings of the OU-3 RI field investigation and data evaluation, the following are the conclusions reached regarding groundwater conditions within and adjacent to Area C:

- Groundwater flow across Area C occurs primarily within the bedrock underlying the area; fractures within the rock mass are the principal migration pathways for groundwater in bedrock.

- The bedrock underlying the study area consists of alternating layers of fine-grained and coarse-grained rock units that are laterally persistent on a local scale. The rock units generally strike to the east-northeast and dip to the north-northwest at about 9°.

- Shallow groundwater flow across Area C is to the north, in the general direction of the slope of ground surface topography and bedrock dip.

- A low concentration plume of PCE has been identified in the northwestern portion of Area C, extending off site to residential wells north of Kirk Road. No obvious source of the PCE has been identified, as there was little or no PCE detected in wells installed within the potential source areas (Site 8, firing range, maintenance area) identified to data near the plume.

- Due to the relatively low concentrations of PCE found near Kirk Road and in potential source areas, it is considered likely that there is no well defined, high-concentration source area for the PCE. The pattern of contamination observed to date is suggestive of several discrete, minor releases rather than a long term, higher intensity source.

- The presence of a significant upward head differential between the deeper bedrock flow zone monitored within Area C, and the shallow bedrock zone is expected to act to prevent contaminant migration to the deeper portions of the bedrock aquifer.

- Carcinogenic risks related to Area C are approximately 10^{-5} for current potential users of groundwater in offsite areas and are driven by the PCE. Calculated risks are within the U.S. EPA target risk range.

- Carcinogenic risks related to Area C are approximately 10^{-4} for potential future receptors and are driven by arsenic and beryllium, which are naturally occurring and appear to be found at representative concentrations below background levels for the area.

- Noncarcinogenic risks are driven by antimony, manganese, thallium, and arsenic. Antimony, manganese, and arsenic are naturally occurring and appear to be found at representative concentrations below background levels for the area. There was only one positive detection of thallium (unfiltered sample only) in Area C.

Recommendations for future groundwater-related site investigation work in Area C include:

- Another round of sampling of the new wells within Area C should be considered to verify the results of the first round of sampling. Low-flow purging and sampling techniques should be utilized to obtain more representative samples for metals analysis.

- Future analysis for antimony should be performed using graphite furnace atomic absorption methods to attain lower detection limits for comparison to regulatory standards.

- Additional wells should be installed within any new potential source areas identified (if any) through Phase III RI investigation activities.

- Aquifer testing should be performed for the shallow bedrock aquifer in the vicinity of the PCE plume, to obtain data for groundwater flow rate and remedial design purposes.

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APPENDIX A

BORING LOGS

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: HN-23S
PROJECT NO.: 1412 DATE: 2-22-94 DRILLER: RA AB
ELEVATION: FIELD GEOLOGIST: D. Whalen
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE TIME	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR:13'					
	15			6" at 15'					
953	18								
	20					TAN	f. gr. Sandstone		
954	24						Lithology as Above		damp / dry
	26					LT. GY	f-gr. Sandstone		DRY
1016	30					Beige	Lithology as Above		
	32								Bit skips 3 times
	33					LT. BRN	F. GR. Sandstone		Fracture
1018	35					Rust-red to Brown	Siltstone/Mudstone		Dusty
	38								Dusty
	40					Pink Gray	F. GR. Sandstone		Very Dusty
	44					Red-brown	V. f. GR. Sandstone		
	45					Pink-Gray	f.-v.f. GR. Sandstone		
1026	50								
						Pink-Gray	f. gr. Sandstone		Dusty
	53					BN	f. gr. Sandstone		No dust
	56								wet
	60					BN	Lithology as Above		~5-10 gpm

REMARKS

BORING HN-23S

PAGE 1 OF 2

* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1029	65					BN	f. gr. sandstone		
	70					LT. BN	M.-Coarse-gr. Sandstone, Some green mineral		
1036	75						Lithology as Above		TOTAL Yield ~20 gpm

REMARKS Water clears after ~ 10 minutes; blow out hole for 20 minutes

BORING HN-23S

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-23 I
PROJECT NO.: 1412 — DATE: 2-17-94 — DRILLER: RA+B
ELEVATION: — FIELD GEOLOGIST: D. Whalen
WATER LEVEL DATA (Date, Time & Conditions):

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR ROD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR: 10'					
	18								
				6" at 18'					
	23								1-2 gpm
1034	24					Tan	f-m.g. sandstone		damp
	28					Tan	MOSTLY QUARTZ; f-m.g. sandstone		damp cuttings
1036	33					red-brown	SILTSTONE		Same DUST
	38					red-brown	SILTSTONE/v.fg. sandstone		DUSTY
1038	41						LITHOLOGY AS ABOVE		Brown MUD blown out; ~3 gpm at 40?
1044	46								WATER FLOWING AT 3-4 GPM
	48								NO RETURNS
1047	50								CLUMPS of MUD
	52					PINK-LT. BRN	v.f. gr. sandstone		DRY, DUSTY
	58					GRAYISH PINK	SLIGHTLY COARSER; fine-vf. gr. sandstone		

REMARKS

BORING HN-23I

PAGE 1 OF 3

* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA: _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1049	61								~4 gpm,
									water flowing
1055	66								MUDDY TO DRY
	69					PINK GRAY	f. gr. Sandstone		DUSTY
	73					LT. BROWN	f. gr. Sandstone		
	76								reddish-brown discharge
1100	81					RED BROWN	Siltstone / v.f. gr. Sandstone		TOTAL YIELD ~7 gpm
									NO HNU
1106	86					RED BROWN	Siltstone		
	88					PINK GRAY	f. gr. Sandstone		Harder
1107	91								
	93					RUST RED TO BROWN	Mudstone / Siltstone		Soft
1111	101					RUST RED	Siltstone		~12 gpm
1116	106					red brown	v.f. gr. Sandstone		some calcite-lined rock frags

REMARKS _____

BORING HN-23I

PAGE 2 OF 3

* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	111					red brown	v.f. gr. sandstone		calcite
1120	116					red brown	v.f. gr. sandstone		
1122	121					red brown	v.f. gr. sandstone		yield ~ 12-15 gpm
	126					LT. BN GRAY			QUARTZ; QUARTZ pebble
	131					GRAY Green	F.G. sandstone; large pieces of M., C.G. sandstone; some conglomerate		
	136					GRAY Green	f. gr. sandstone		Q - "brownish"
1133	141					PINK GRAY	f. gr. sandstone		Q - clear yield > 20 gpm
1145	151		TD						

REMARKS _____

BORING HN-23I

PAGE 3 OF 3

* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN - 24 S
PROJECT NO.: 1412 — DATE: 3/1/94 — DRILLER: RAAB
ELEVATION: — FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE Time	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR: 8'					
1500	16			6" at 16'		BRN	F. Gr. Sandstone		DRY
	19						Some interbedded reddish siltstone		
	20								
						LIGHT reddish			
	24					GRAY & Brown	F. Gr. Sandstone		DRY
1504	25					BN	F. Gr. Sandstone		DRY
	28								Soft/Damp Zone?
	30								APPX: 29-30: Soft or Fractured
	31					Brown Gray, &	Interbedded Mudstone or Shale, Siltstone and		DRY
						reddish	F. Gr. Sandstone		↓
1509	35					Gray & Brown	F. Gr. Sandstone		
	40								
									43-45: Damp Zone Poss. water yield
									≤ 1 GPM
1512	45					Brown & Gray	F. Gr. Sandstone		
	47						Few thin softer reddish shale, mudstone, or siltstone layers		Dry to Damp
1518	50					Brown & Gray	F. Gr. Sandstone		Dry - Damp
1520	55						- Same As Above -		
1523	60						- Same As Above -		

REMARKS: 6-Inch Steel Casing to 16 FT - Drill out with 6-inch hammer bit, IR T-3 Drill rig, Air Only

BORING HN-24S

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS: 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1525	65						— Same as Above —		
1527									
	70						— Same as Above —		
1532	75						— Same as Above —		
	77								Appx. 77 ft: Probable increase in water
	80						75-85: Some reddish Mudstone/Shale/Siltstone Layers interbedded		
1537	85					Brown & Gray	F. Gr. Sandstone		
1543									
1544	90						— Same as Above —		
									92-93: possible moisture
1546	95						— Same as Above —		
1548	100						— Same as Above —		
1550									
1556	105								Total yield now 3 GPM Maximum
	108						* Some Lighter, Greenish-Gray Sandstone		
1558	110								110: Possible increased water

REMARKS _____

BORING HN-245

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* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	113								
1601	115								Possible moist or soft zones
	117					BRN	FGR Sandstone; Softer		
1607	120								
						REDDISH Brown	MUDSTONE + SILTSTONE		
	122					GRAY	FGR. Sandstone, Harder		Poss, increased water
1606	125								

REMARKS TOTAL YIELD 3-4 GPM maximum. Develop borehole with air APPX. 1 hour

BORING HN-24S

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-24 I
PROJECT NO.: 1412 — DATE: 2/18/94 — DRILLER: RAAB
ELEVATION: — FIELD GEOLOGIST: D. Whalen
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE Time	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR; 8'					
1043	16			6" at 16'		red, pink gray	v. f. gr. Sandstone		Dry
1044	20								
	21					red-brown	MUDSTONE		DUSTY
	23								very DUSTY, Soft
1047	25								
1048	26					Brown	f.-vf. gr. Sandstone		DUSTY
1050	30								DUSTY
	33					LT. Brown	f.-vf. gr. Sandstone		
1052	35					rust red brown	MUDSTONE		Soft, DUSTY
	39					red brown	v.f. gr. Sandstone/Siltstone		DUSTY, harder
	42					Pink Gray	f. gr. Sandstone		
1057	45								Some MUD Discharges
	49					Brown	vf.-f. gr. Sandstone		
1102	50								
	52								Soft, no DUST
1103	55					Pink Gray,	vf. f. gr. sandstone		Louder; fine sand in cuttings
	59					LT. Brown			Fracture ?
1105	60								

REMARKS

BORING HN-24 I

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* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	63								DUSTY
1107	65					PINK-GRAY	vf.-f. gr. sandstone		Blow hole out; <1 gpm
	67								DUSTY
	70					Pink GRAY	vf.-f.-gr. Sandstone		Sandy Cuttings
	72								
	77								Dusty, Soft
	79								Quiet, no hammer
1117	80								(fracture?)
	82					rust red -	Siltstone/v.f.-gr. Sandstone		Soft; blow <1 gpm out of hole at rod
						brown			connection
	89					rust red	Mudstone/Siltstone		
1121	90								NO DUST
	97					Pink-GRAY	F-GR. Sandstone		NO DUST
	99								DAMP
1124	100								
	103								NO DUST
	104								MUD
	105						Lithology As Above		~1-2 gpm TOTAL
	108								water dripping
1132	110								WET MUD

REMARKS _____

BORING HN-24 I

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* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA: _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR ROD (ft.)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	112								WET MUD
1134	115					LT. Brown, Pink-Gray	f. gr. Sandstone		~2-3 gpm
	119								Decrease Yield
1137	120								NO RETURN
	121								~1 gpm
	122								NO NOISE-QUIET
	124					MED RED-brown	Siltstone/v.f.gr. Sandstone		NO RETURN
1143	126								2-3 gpm TOTAL
	130						Lithology AS Above		~1 gpm
	131					MED. brown	v.f. gr. Sandstone		
1149	135						Lithology AS Above		MUDDY; bit SKIPS
	138								~2-3 gpm
1153	140								
									Yield Decrease
									NO/SLIGHT FLOW
1156	145						Lithology AS Above		
									~1-2 gpm TOTAL
	149					Pink, GRAY	f. gr. Sandstone (COARSER)		DAMP, no flow
	152								DRY
1207	155					GRAY-brown	Lithology AS Above		MUD; bit SKIPS
	158								~1 gpm
	160								WET MUD

REMARKS _____

BORING HN-24I

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* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
-	161								NO FLOW
1214	165					GRAY brown	f. gr. sandstone		WET MUD; blow ~1 gpm out of hole
	168								DRIPPING
	170						LITHOLOGY AS ABOVE		WET MUD
	172								NO FLOW
1223	175					GRAY brown	vf.-f. gr. sandstone		DAMP CUTTINGS
1225	180					red brown	MUDSTONE/SILTSTONE		DRY
1227	185						LITHOLOGY AS ABOVE		DRY, blow some H_2O
	187								DURING ROD CONNECT. WET MUD
1235	190					red brown	SILTSTONE/v.f.-gr. sandstone		
	192								DRY
1238	195								bit skips and muddy returns
1241	200								
1244	205					red brown	v.f. gr. sandstone		TOTAL YIELD ~3 gpm

REMARKS _____

BORING HN-24I

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BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-25S
PROJECT NO.: 1412 — DATE: 3-4-94 — DRILLER: RAAB
ELEVATION: — FIELD GEOLOGIST: Kevin C. Kilmartin
WATER LEVEL DATA (Date, Time & Conditions):

SAMPLE NO. & TYPE / Time	DEPTH (ft.) OR RUN NO.	BLOWS 5" OR ROD (ft.)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR: 16'					
	20					brown-RED	M. GR. Sandstone		DRY
				6" at 20'					
1205	25								No HNU > BK
	30					brown-RED	M. GR. SANDSTONE LOTS of SKIPS (FRACTURES?)		DRY
	33						Much more Chatter - BEDS more Competent		
	37								Fracture ?
	40					GRAY	Cuttings lighter color		DRY
1215	45						Blow hole out; <<.5 gal		No HNU > BK
	50						Cuttings + Dust suppressed Competent rock - LOUD		DRY
	55						Possible fracture		Dry cuttings,
	56						Hole making little water (<<.5 gpm)		occassional mud

REMARKS

BORING HN-25S

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA: _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1232	65								~10 gal of
									Connection water
	70					RED-brown	MUDSTONE		Softer drilling
	77						SKIP, fracture?		no returns
	80						SKIP, fracture		
	83			*			Fracture? lots of SKIPS		>10 gpm
1255	85		TD						Final Yield EST
							Interconnection		12-14 gpm
							with HN-25I		
							(blow water out of borehole)		

REMARKS Blow hole to 1315, water cleaned up fairly well, still slightly murky. Ron Slotto reports that HN-25I was also murky.

BORING HN-25S

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-25I
PROJECT NO.: 1412 — DATE: 3-2-94 — DRILLER: RAAB
ELEVATION: — FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE Time	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR: 16'					
1014	20								
				6" out 20'		BRN	FGR Sandstone		
1016	25					BRN	FGR Sandstone		APPX 1-2 gpm from This interval
							27-28': softer or possible fractures		
1020	30					RED-BRN	Siltstone/Mudstone/Shale		
1022	35					BRN & GRAY	FGR Sandstone, harder		Water Increase, poss. few gpm More
1025	40						- Same as above -		
1027	45						Same as above - some interbedded reddish Siltstone/Shale/Mudstone		Now est. total yield 8-10 gpm
1032	50					BRN & GRAY	FGR Sandstone		
1035	55						- Same as above -		
1037	60						- Same as above -		

REMARKS 6-inch steel casing to 20 ft. B.G.S. - Drill out with 6-inch air hammer bit, IR T-3 Drill Rig, air only

BORING HN-25I

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
						BRN & GRAY	FGR Sandstone		Gradual increased yield 45 to 65'
	65						-Same as above-		TOTAL yield now
									at ~12 gpm
	70						-Same as above-		
1047	75						-Same as above-		76-79; possible water increase
	80						-Same as above-		80-81' - softer or fractured
	85						-Same as above-		TOTAL yield EST. at ± 20 gpm
	90						-Same as above-		
1102	95						-Same as above-		
	100					REDDISH BROWN	Siltstone/Mudstone/Shale		
									Possible water
									increase 100-110
1107	105						-Same as above-		
	110					RD, BRN & BROWN	FGR sandstone interbedded with siltstone, mudstone, and shale		

REMARKS _____

BORING HN-25I

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR OR USCS	REMARKS
1117	115					BRN & GRAY	FGR Sandstone		
	120						-Same As Above-		121: possible fracture & water increase
						LIGHT			
1125	125					REDDISH GRAY	FGR Sandstone		TOTAL YIELD ESTIMATED at 25-30 GPM
	130					LT. GRAY TO WHITE	FGR Sandstone		130' + Possible water increase
						LIGHT			
1138	135					REDDISH GRAY	FGR Sandstone		
	137					BRN	FGR Sandstone		SOFT Zone; possible water increase
	142					REDDISH BROWN	Siltstone/Mudstone/Shale		
1143	145								TOTAL YIELD
									± 30gpm est.

REMARKS _____

BORING HN-25I

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-26S
PROJECT NO.: 1412 — DATE: 2/22/94 — DRILLER: RAPA
ELEVATION: — FIELD GEOLOGIST: Don Whalen
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE Time	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR: 8'					
1323	15			6" at 15'		red-brown	vf-f.gr. sandstone		DRY
	20					red-brown	vf-f. gr. sandstone		DUSTY
	22					rust red	MUDSTONE		
1327	25					Pink-Gray	vf-f. gr. sandstone		DUSTY
	28					Bn-Gray	f-vf. gr. sandstone		
1331	30								fracture
	32					red-brown	v.f. gr. sandstone		moist
	34								MUD returns
	35								~2 gpm
1334	40					brown			damp
1336	45					brown	v.f.gr. sandstone		4-5 gpm total
	48					brown-gray	f. gr. sandstone		
1345	50								WET MUD
									DAMP
									WET
1348	55					brown-gray	f. gr. sandstone		Yield ~ 5-6 gpm

REMARKS

BORING HN-26S

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-26 I
PROJECT NO.: 1412 — DATE: 2/17/94 — DRILLER:
ELEVATION: — FIELD GEOLOGIST: D. Whalen
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE Time	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR: 8'					
1444	15			6" at 151		red-brown	Siltstone/v.f. gr. sandstone		dry
	20						Lithology as Above		dry
	23					rust red	Mudstone		dry
1448	25					red-brown	Siltstone/v.f. gr. sandstone		v. thinly bedded
1451	26					Pink-gray	v.f. gr. sandstone		dusty
	30								dusty
	33					red-brown	Siltstone (finer-grained)		Damp, no dust
	35								wet, < 1 gpm
1457	40					red-brown			damp
	43								soft; wet
1500	45					red-brown			wet; muddy
1503	47						Adjust rig 1503-1510		dry
1511	50								
	51					Pink gray	f. gr. sandstone		Damp
1513	55					Pink gray	vf-f. gr. sandstone		dusty
	57					Pink gray	f. gr. sandstone (coarser)		wet
1515	60								dried up; dusty

REMARKS

BORING HN-26 I

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* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER BORING NO.: HN-26 I
PROJECT NO.: 1412 DATE: 2/17 DRILLER:
ELEVATION: FIELD GEOLOGIST: D. Whalen
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE Time	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR ROD (ft.)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
-	62					LIGHT Brown	f. gr. Sandstone		
	64					TAN - LT. Brown	f.gr. Sandstone; iron-stains		DAMP
	66								Yield ~ 2 gpm
									MUDDY
1522	70					Brown			DAMP
	72						f.- v.f. gr. sandstone		WET
1524	75								Damp; no DUST
	76					Brown	f.-vf.-gr. Sandstone		Some MUD
1526	80					Brown	f. gr. Sandstone		Damp TO DUSTY
	82								Louder drilling; WET
	84								DAMP
1529	85								
	87								
1534	90					Brown	vf.-f.gr. Sandstone		DAMP, Some DUST
	94					rust red	SILTSTONE		DUSTY
1536	97								Some DUST
1538	100								
	101					rust red	SILTSTONE/MUDSTONE		
	102								Soft
1539	105					rust red	SILTSTONE/MUDSTONE		DUSTY
									DAMP
1544	110					rust red	MUDSTONE		SOFT

REMARKS

BORING HN-26 I

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BORING LOG — **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA: _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE Time	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	-								DUSTY
	115					brown	V.f. gr. sandstone		harder drilling
	119					Pink-Gray	f.- vf. gr. sandstone		
									Some dust
	126								Yield 1-2 GPM
	127					Gray	f. gr. sandstone		Some dust
1556	130								
1601	135					brown	siltstone		
									Muddy Flow
	140								~2-3 gpm
1606	145					brown	siltstone		yield ~5 gpm
	148					red-brown	siltstone/v.f. gr sandstone		
	151					brown	f. gr. sandstone		
1617	155					brown	f. gr. sandstone		
1619	160					brown	slightly coarser grained		

REMARKS _____

BORING HN-26I

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BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	164					red-brown	SILTSTONE		
									Yield ~6 gpm
1628	170					red-brown	SILTSTONE/v.f.gr. Sandstone		
1632	175								
	182					GRAY	f. gr. Sandstone		black film
1636	185					GRAY			Yield ~7 gpm
1643	190					LT. Green GRAY	MED-f.gr. Sandstone		black film
									↓
1646	195					Pinkish	f.-MED gr. Sandstone		
	199					LT. GRAY Green	f.-Med gr. Sandstone		black film
1652	205					LT. GRAY Green	f.-Med gr. Sandstone		~10gpm Total Yield
									~1/2 from green-gray sandstone

REMARKS _____

BORING HN-26I

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BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-27S
PROJECT NO.: 1412 — DATE: 2/21/94 — DRILLER: RAAB
ELEVATION: — FIELD GEOLOGIST: D. Whalen
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE TIME	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR ROD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				16'-8'					
1344	16					red-brown			DUSTY
				6" at 16'					
	19					Brown	f. gr. sandstone		
	20					red-brown	v.f.-gr. sandstone		DUSTY
	22					Pink-GRAY	v.f. gr. sandstone		
1349	25								DUSTY
	28								DUSTY
1353	30					LIGHT Brown	f. gr. sandstone		Powdery
	32					GRAY	f. gr. sandstone		
1355	35					LT. Brown TAN	f. gr. sandstone		DUSTY
1357	40					LT. Brown GRAY	f. gr. sandstone		DUSTY
	44					LT. Brown			
1358	45					red-brown	Siltstone/v.f. gr. sandstone		
									<< 1 gpm blown out of hole
1403	50					BN	v.f. gr. sandstone		
	52					LT. Brown	f. gr. sandstone		Powdery
	53								DUSTY
1406	55					red-brown	v.f.-f. gr. sandstone		
	56					GRAY			DUSTY
1408	60					LT. Brown	f. gr. sandstone		

REMARKS

BORING HN-27S

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BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 5" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
-	61					gray-LT. Brown			fracture ?
	62					yellow-LT. Brown	f. gr. sandstone (coarser)		
1411	65								<1 gpm total
	66								DRY
1415	70						LITHOLOGY AS ABOVE		DRY
	75						LITHOLOGY AS ABOVE		
	79					TAN	f. gr. sandstone		DRILLING SKIPS
	80					red-brown	SILTSTONE/v-f. gr. sandstone		
1423	85					rust red	MUDSTONE (soft)		<1 gpm total
	87								DUSTY
1430	90					red brown	SILTSTONE/v-f. gr. sandstone		DUSTY
1432	95					rusted brown	SILTSTONE		DUSTY
1434	100					rust red	MUDSTONE		
1436	105					PINK-GRAY	f. gr. sandstone		

REMARKS _____

BORING HN-27S

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BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-27 I
PROJECT NO.: 1412 — DATE: — DRILLER: RAAB
ELEVATION: — FIELD GEOLOGIST: D. whalen
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE / TIME	DEPTH (ft.) OR RUN NO.	BLOWS 5" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	-			TOR: 8'					
1511	15			6" at 15'		red-brown	Siltstone/Mudstone		Soft
	19								hard/loud hammering
	21								dusty, red
	22					red-brown	v.f.gr. Sandstone/Siltstone		
	24					Pink-gray			Dusty
1515	27					Pink-gray	v.f.gr. Sandstone/Siltstone		Dusty
	28								No dust
1519	32					brown	f. gr. Sandstone		Moist
1522	37					Dark brown	v.f. gr. Sandstone		
	40								water, wet cuttings
1523	42						Lithology as Above		soil-like;
									damp cuttings
1526	47						Lithology as Above		
1529	50								
1531	52						Lithology as Above		Blow <5 gpm out of hole
	54								~1 GPM flow
1546	55								No flow
1548	57					Med Brown	v.f. gr. Sandstone		Damp
	60								~1 GPM flow

REMARKS

BORING HN-27 I

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BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR ROD (ft.)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1552	62					LT. Brown TAN	f. gr. Sandstone		
	66								1-2 GPM
1555	67					LT. Brown	f. gr. sandstone		START TO GET FLOW
	70								DUSTY
1559	72						Lithology AS Above		DAMP, no Flow
1602	77					beige	f. gr. Sandstone		DAMP, no Flow
	80								hammer QUIET
1607	82					DARK brown	v. f. gr. Sandstone		DAMP
	86								Some flow, Thick
1610	87					red-brown	Siltstone		MOIST
1613	92					red-brown	Siltstone		very little return
	95								Thick returns
1618	97					red-brown	v. f. gr. sandstone		DAMP
	99								DUSTY, SOFT
1620	102					red-brown	Siltstone/MUDSTONE		DUSTY
									Blow < 5gpm out of hole
	105								NO Flow
	107					LIGHT Brown	f. gr. sandstone		WET
1630	110								DUSTY

REMARKS _____

BORING HN-27I

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BORING LOG — **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA: _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 5" OR ROD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1631	112					Pinkish, L. Brown	v.f. gr. Sandstone		DUSTY
1633	115								
1634	117					beige	v.f. gr. Sandstone		DUSTY
1638	122					TAN	v.f.-f.gr. Sandstone		DUSTY
1641	127					beige	v.f.gr. Sandstone		DUSTY
	128								no dust, no flow
1647	132					Light Brown	f. gr. Sandstone		DAMP
1649	135					red brown	Siltstone/v.f.gr. Sandstone		
1653	137					red brown	Siltstone		DUST
	140								Possible fracture
1655	142					red brown	v.f.gr. Sandstone		MOIST
	149								Some Flow
	150								H_2O
1659	152								~ 5 gpm
1709	160								TOTAL YIELD ~8 gpm

REMARKS Blow hole out until 1723.

BORING HN-27

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BORING LOG — **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: HN-28 S
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA: _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE Time	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR: 10'					
				6" at 19'					
1527	19					Pink, gray-DN	vf.-f. gr. Sandstone		dry
1529	24						Lithology as Above		dry
	27					gray	vf.-f. gr. Sandstone		dusty
1532	29								
	32								dusty
	34						Lithology as Above		
	39					red-brown	f. gr. Sandstone (slightly Coarser)		
	42					red-brown	vf-f. gr. Sandstone		dusty
1537									
	48					brown	vf-f. gr. Sandstone		damp
	50					red-brown	Siltstone & vf. gr. Sandstone		
1544	55					rust-red	Siltstone/Mudstone; very soft		dusty
1545	59								

REMARKS _____

BORING HN-28S

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BORING LOG — **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: HN-28S
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
-	62								no DUST; DAMP CUTTINGS
1546	64					rust RED	Siltstone/mudstone;		~1-2 gpm Total
							Some vf. gr. Sandstone		
1552	69						Lithology as Above		
1553	74						Lithology as Above		
	78					brown	Siltstone; v.f.gr Sandstone		damp, no dust
1557	84					red-brown	Siltstone/mudstone SOFT		2-3 gpm total

REMARKS hear cascading water after drilling Completed

BORING HN-28S

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BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-28 I
PROJECT NO.: 1412 — DATE: 2/14 - 2/16/94 — DRILLER: RAAB
ELEVATION: — FIELD GEOLOGIST: D. Whalen
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	1					BN	SILTY LOAM, clayey silt		
	5					BN	CLAYEY SILT and f.gr. sandstone fragments		
1428									
	10					Red-brown	SILTSTONE/f.gr. SANDSTONE		
				TOR at 10'					
2/14 1432									
	15					rust red	MUDSTONE/ SILTSTONE		SOFT, WAXY
↑	17					red-brown	v.f-gr. SANDSTONE		HARDER
↓	20			6" at 18'			v.f-gr. SANDSTONE/SILTSTONE		DRY
2/16									
1015	24								blow water out of hole
	29					Pink-brown	v.f. gr. SANDSTONE		
1019	34					Light Brown	v.f. gr. SANDSTONE		
	39						LITHOLOGY AS Above		START TO ADD ~3 GPM of water
1022	44						LITHOLOGY AS Above		TOTAL YIELD 1-2 gpm, picked up H2O at end of rod
	50								

REMARKS

BORING HN-28I

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BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1030	52								
	54					red-brown	Siltstone		
									Some "soft" spots, pick up a little H2O
	59					red-brown	Siltstone/v.f.gr. Sandstone		
1034	64					rust red, brown	Siltstone/Mudstone		TOTAL Yield ~ 5 gpm
									NO HNU > BK
1043	74					rust red	Siltstone/Mudstone		STOP TO BLOW OUT HOLE
1046	79								
1049	84					red-brown	Siltstone/v.f.gr. Sandstone		TOTAL Yield ~5 gpm
1056	89					Med brown	v.f. gr. Sandstone		
1059	94								
	98					Light brown	f. gr. Sandstone		

REMARKS _____

BORING HN-28I

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BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 5" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1103	104					LIGHT Brown	f.gR. Sandstone		TOTAL Yield ~5gpm
	109						Lithology As Above		
1111	114						Lithology As Above		
1114	119						Lithology As Above		
1116	124						Lithology As Above		
	126					rust red	MUDSTONE		
	129								NO returns; blow out hole several times
1126	134					brown	f. gr. Sandstone		
1130	144					brown	f. gr. Sandstone		
	150								

REMARKS _____

BORING HN-28I

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BORING LOG — **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	154					GRAY	f. gr. Sandstone		
1148	164								Total Yield
									6-8 gpm
	169						Large pieces of Brown siltstone. Blow out hole several times		Pick up ~5 gpm
						LIGHT GRAY	f. - M. gr. Sandstone		
	174					LIGHT GRAY	f. - M. gr. sandstone; some green mineral and white calcite		
1216	184						T.D.		Total Yield
									15-20 gpm

REMARKS * Hole keeps caving in; seems to get worse after being blown out; caves in up to ~12 ft off bottom. 1300: pull up rods.

BORING HN-28I

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BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-29S
PROJECT NO.: 1412 — DATE: 3-7-94 — DRILLER: RAAB
ELEVATION: — FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA (Date, Time & Conditions):

SAMPLE NO. & TYPE Time	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR: 8'					
1057	15			6" at 15'		red-brown	MUDSTONE, SILTSTONE, & Shale		DRY
1059	20						- Same as above -		
1102	25					red-brown	MUDSTONE, SILTSTONE, & Shale		DRY
1105	30						- Same as above -		29-30' - possible water increase - interconnection with 29 I
1110	35								
1113	40						- Same as above -		possible Q increase
1116	45						- Same as above -		soft or fractured, Possible Q increase, 2-3 gpm TOTAL
1124	50								" harder" at 48-49
	52					Brown, GRAY	FGR Sandstone		Q increase 50-55', Fx. cuttings > 1-inch
1126	55						- Same as above -		≥ 10 gpm now
1128	60					red-brown	MUDSTONE, SILTSTONE, & Shale		Large fractured pieces borehole washing out

REMARKS: 6-inch steel casing TO appx. 15 ft Drill with 6-inch air hammer 15 ft TO 65 ft.

BORING HN-29S

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BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 5" OR ROD (ft.)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1130	65						-Same as above-		EST. 15-20 gpm Total
				TD					

REMARKS _____

BORING HN-29S

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BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-29 I
PROJECT NO.: 1412 — DATE: 2/16 & 2/21 — DRILLER: RAAB
ELEVATION: — FIELD GEOLOGIST: Don Whalen
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR at 8'					
1617	20			6" at 20'		Brown	Mudstone		v. soft, damp
	22								adjust rig
1622	28					red-brown	Mudstone		soft, damp
1625	31								no returns
	33					Brown	v.f. gr. sandstone		hard, damp
1632	41					Brown	v. f. gr. sandstone		hard, damp
	44					Brown			wet cuttings
	47					Brown	v.f.-f. gr. sandstone		damp
2/16							some iron staining		soft
1639	53					Brown	v. f. gr. sandstone		yield ~ 1 gpm
↑									
↓	56					Red	mudstone/siltstone		Blow H_2O from hole
2/21									soft
	920	60				red-brown	siltstone/mudstone		wet cuttings; soft

REMARKS

BORING HN-29I

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA: _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
922	65					red-brown	Siltstone/mudstone		Soft, wet cuttings,
									yield basically
926	70					red-brown	Siltstone/f. gr. sandstone		0 gpm
	72								wet mud
929	75						f. gr. sandstone		
931	80					brown	f. gr. sandstone		~2 gpm yield
933	85					brown	f. gr. sandstone		~4 gpm yield
938	90					brown	f. gr. sandstone		wet mud
	92					red-brown	v. f. gr. sandstone		
									Q increase
941	95					red-brown	f-v.f. gr. sandstone		3-4 gpm total
942	100					brown	f. gr. sandstone		
945	105					brown	f. gr. sandstone		~4-5 gpm
	110					brown	f. gr. sandstone		

REMARKS _____

BORING _____

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BORING LOG — **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	112					red-brown	v.f. gr. Sandstone		
	115								~4 gpm
954	120					brown	f. gr. Sandstone		
957	125					brown	f. gr. sandstone		
	128					red-brown	Mudstone (very soft), w/ brown, fg. Sandstone &		Blow out hole;
1011	130						green, fg. Sandstone & a greenish mineral		rock fragments
1015	135						Lithology as Above		Yield ~10 gpm
1018	140					pink-gray	Mix of pink-gray, f.-mg. Sandstone, rust-red		
							Siltstone, and soft green mineral		
1020	145					pink-gray	Mostly pink-gray, f.gr. Sandstone, some soft,		Total Yield
							rust-red mudstone, and soft green mineral		~15 gpm

REMARKS _____

BORING _____

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BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-30
PROJECT NO.: 1412 — DATE: 2/8 & 2/10 — DRILLER: RAAB
ELEVATION: — FIELD GEOLOGIST: Don Whalen
WATER LEVEL DATA
(Date, Time & Conditions)

	SAMPLE NO. & TYPE / Time	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
							brown	clayey silt		
	1043	6								
	1048									
	1052	10								dusty
							red brown	silty clay		
							Pink-Gray	f. gr. sandstone		
2/8					TOR IN 15'					
4	1107	20								
↓					6" at 20'		Pink-Gray	f. gr. sandstone		dusty
2/10										
		25						Lithology as Above		
	1538	27								
	1540	32								
	1541	35						Lithology as Above		dusty
	1543	39					red brown	Siltstone/Mudstone		dusty
	1544	42								
		45					red brown	Mudstone		dusty, very soft
	1545	47								lift up bit, blow
		50								out hole.

REMARKS

BORING HN-30

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BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-30
PROJECT NO.: 1412 — DATE: 2/8 & 2/10 — DRILLER:
ELEVATION: — FIELD GEOLOGIST: Don Whalen
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1549	52					red brown	MUDSTONE		dusty, soft
1553	55								
1554	57						LITHOLOGY AS ABOVE		
	60								
1555	62								
						gray	v.f.- f.gr. sandstone		dusty, harder
1556	65								
	67					red-brown	SILTSTONE/MUDSTONE		
1557	69					gray	v.f.-f.gr. sandstone		
1558	72					red-brown	f.gr. sandstone w/mica		
	74					pink-gray	f.gr. sandstone w/mica		wet cuttings
1600	77								TOTAL YIELD <5gpm
1610	82					pink-gray	fine-grained sandstone		
	85								no flow
1611	87								
1613	92						LITHOLOGY AS ABOVE		
1616	97						LITHOLOGY AS ABOVE		
1620	102					pink-gray	fine-grained sandstone		TOTAL YIELD ~5gpm

REMARKS

BORING HN-30

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* See Legend on Back

BORING LOG — **HALLIBURTON NUS**

PROJECT: NAWC WARMINSTER — BORING NO.: HN-34S
PROJECT NO.: — DATE: 2/16/94 — DRILLER: RAAB
ELEVATION: — FIELD GEOLOGIST: R. GOOD
WATER LEVEL DATA (Date, Time & Conditions):

SAMPLE NO. & TYPE TIME	DEPTH (ft.) OR RUN NO.	BLOWS 5" OR ROD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
				TOR: 10'					
1220	16			6" at 16'		Brown	F.GR. Sandstone		DRY
1224	20					Brown	F. Gr. Sandstone		Dry
1226	25					Brown Gray	V.F.GR - F.GR. Sandstone		DRY
	27								Possible fracture
1230	30					Brown, Gray, + reddish Gray	ALTERNATING Layers of FGR. Sandstone		DRY
1233	35						- Same as above -		DRY
1236	40						- Same as above -		DRY
	44								Fracture or soft zone
1238	45						- Same as above -		
	46								Fracture or soft zones 46-48 feet
1245	50					BRN	F.GR. Sandstone		DRY - NO MOISTURE after rod connection
	52					red, reddish	ALTERNATING LAYERS Shale or MUDSTONE, SILTSTONE, &		
						Gray, + Gray	V.F.Gr - F.GR. SANDSTONE		
1247	55					Brown Gray, & reddish Gray	F.Gr. Sandstone		DRY, Slightly harder
1250	60						- Same As Above -		DRY

REMARKS: 6-inch Steel casing TO 16 ft. Drill out of casing with 6-inch bit.

BORING HN-34S

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* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
	62								Possible fractures 61-62
1253	65						-Same as above-		DRY
1257	70						-Same as above-		DRY
									Few soft zones or
									Fractures 71-75 ft
1300	75					Brown, Gray, &	FGR Sandstone, alternating LAYERS		Some Moisture after Rod connection:
						reddish Gray			(<< 1 gpm), Then DRY
1328	80						-Same as above-		DRY
	84								83-84: Soft or Fractured zones
1331	85						-Same as above-		DRY
1334	90						-Same as above-		DRY
	92					More brown			92.5 - Soft or fractured, Brown DUST, NO
						or olive brown			DUST, Then water at ±20 GPM est.
1337	95						-Same as above-		
									96-97: Possible Fractures and
	97					More GRAY & LT. GRAY	Poss. More M.GR.-C.GR. SANDSTONE present, some		Increased water
							White to Light Green calcite.		
							FGR. SANDSTONE w/ Some		STILL Producing ±20 GPM est.
1340	100					GRAY	MGR-C.GR SANDSTONE; Some White CALCITE COATINGS on Fracture surface		WATER Somewhat Clear

REMARKS _____

BORING HN-342

PAGE 2 OF 3

* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: _____ BORING NO.: _____
PROJECT NO.: _____ DATE: _____ DRILLER: _____
ELEVATION: _____ FIELD GEOLOGIST: _____
WATER LEVEL DATA _____
(Date, Time & Conditions) _____

SAMPLE NO. & TYPE	DEPTH (ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth, ft.)	MATERIAL DESCRIPTION* SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
1348	105								TOTAl Depth 105 FT.

REMARKS Develop borehole APPX. 20 minutes - water became fairly clear within a few minutes

BORING HN-34S

PAGE 3 OF 3

* See Legend on Back

APPENDIX B

WELL CONSTRUCTION DIAGRAMS

NUS CORPORATION
A Halliburton Company

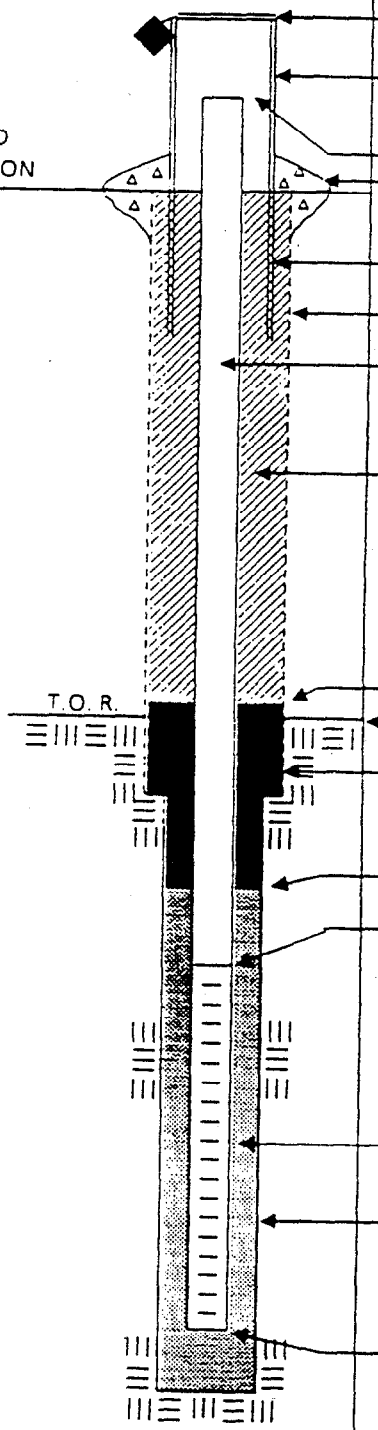
BORING NO.: HN-23S

BEDROCK MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT NAWC WARMINSTER
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST D. Whalen

LOCATION WARMINSTER PA
BORING HN-23S
DATE

DRILLER RAAB
DRILLING METHOD Air ROTARY
DEVELOPMENT METHOD CENT. PUMP



ELEVATION OF TOP OF SURFACE CASING:

STICK UP OF CASING ABOVE GROUND SURFACE:

ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement Grout

I.D. OF SURFACE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION / DEPTH TOP OF SEAL:

ELEVATION / DEPTH TOP OF BEDROCK: 13

TYPE OF SEAL: Bentonite

ELEVATION / DEPTH TOP OF SAND: 49

ELEVATION / DEPTH TOP OF SCREEN: 52

TYPE OF SCREEN: Sched 40 PVC

SLOT SIZE x LENGTH: .020-inch X 10 feet

I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: 6-inch

ELEVATION / DEPTH BOTTOM SCREEN: 62

ELEVATION / DEPTH BOTTOM OF HOLE: 73

Backfilled w/ bentonite to 65

NUS CORPORATION
A Halliburton Company

BORING NO.: HN-23I

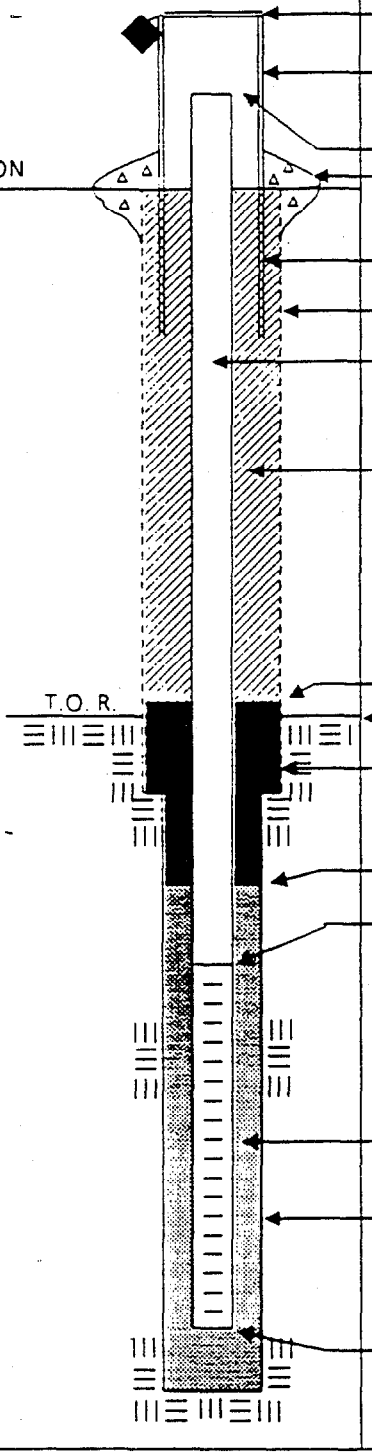
BEDROCK MONITORING WELL SHEET

WELL INSTALLED IN BEDROCK

PROJECT NAWC WARMINSTER
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST D. Whalen

LOCATION WARMINSTER, PA
BORING HN-23I
DATE

DRILLER RAAB
DRILLING METHOD AIR ROTARY
DEVELOPMENT METHOD NATURAL (ARTESIAN)



ELEVATION OF TOP OF SURFACE CASING:

STICK UP OF CASING ABOVE GROUND SURFACE:

ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement Grout

I.D. OF SURFACE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION / DEPTH TOP OF SEAL:

ELEVATION / DEPTH TOP OF BEDROCK: 10

TYPE OF SEAL: Bentonite

ELEVATION / DEPTH TOP OF SAND: 125

ELEVATION / DEPTH TOP OF SCREEN: 136

TYPE OF SCREEN: Sched 40 PVC

SLOT SIZE x LENGTH: .020-inch x 10 feet

I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: 6-inch

ELEVATION / DEPTH BOTTOM SCREEN: 151

ELEVATION / DEPTH BOTTOM OF HOLE: 151

HALLIBURTON NUS
Environmental Corporation

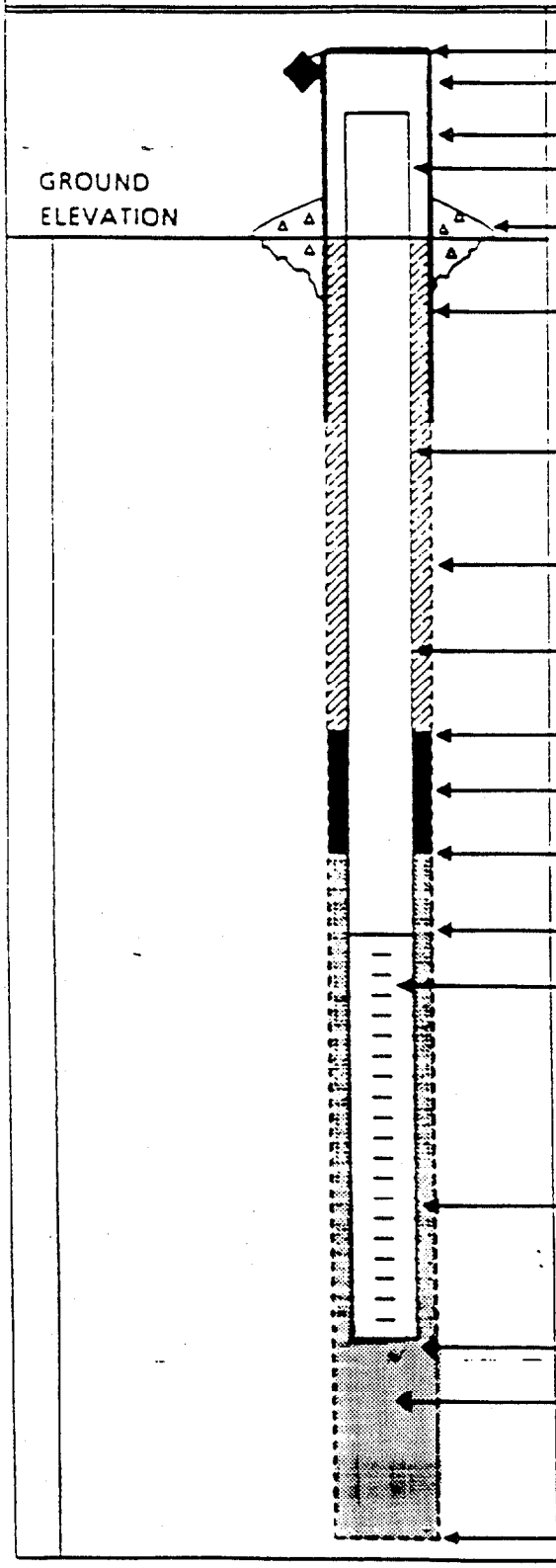
BORING NO HN-23

OVERBURDEN
MONITORING WELL SHEET

PROJECT NAWC WARMINSTER
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST D. Whalen

LOCATION WARMINSTER PA
BORING HN-23X
DATE

DRILLER RAAB
DRILLING METHOD AIR ROTARY
DEVELOPMENT METHOD CENT. PUMP



ELEVATION OF TOP OF SURFACE CASING:
ELEVATION OF TOP OF RISER PIPE:
STICK - UP TOP OF SURFACE CASING:
STICK - UP RISER PIPE:
TYPE OF SURFACE SEAL: Cement Grout
I.D. OF SURFACE CASING: 6-inch
TYPE OF SURFACE CASING: STEEL
RISER PIPE I.D. 2-inch
TYPE OF RISER PIPE: Sched 40 PVC
BOREHOLE DIAMETER: 6-inch
TYPE OF BACKFILL: bentonite
ELEVATION / DEPTH TOP OF SEAL:
TYPE OF SEAL: bentonite
DEPTH TOP OF SAND PACK: 6
ELEVATION / DEPTH TOP OF SCREEN: 7
TYPE OF SCREEN: Sched 40 PVC
SLOT SIZE x LENGTH: .020-inch X 5 ft
I.D. OF SCREEN: 2-inch
TYPE OF SAND PACK: #2 Morie EQUIV.
ELEVATION / DEPTH BOTTOM OF SCREEN: 12
ELEVATION / DEPTH BOTTOM OF SAND PACK: 12
TYPE OF BACKFILL BELOW OBSERVATION WELL: N/A
ELEVATION / DEPTH OF HOLE: 12

NUS CORPORATION
A Halliburton Company

BORING NO.: HN-24S

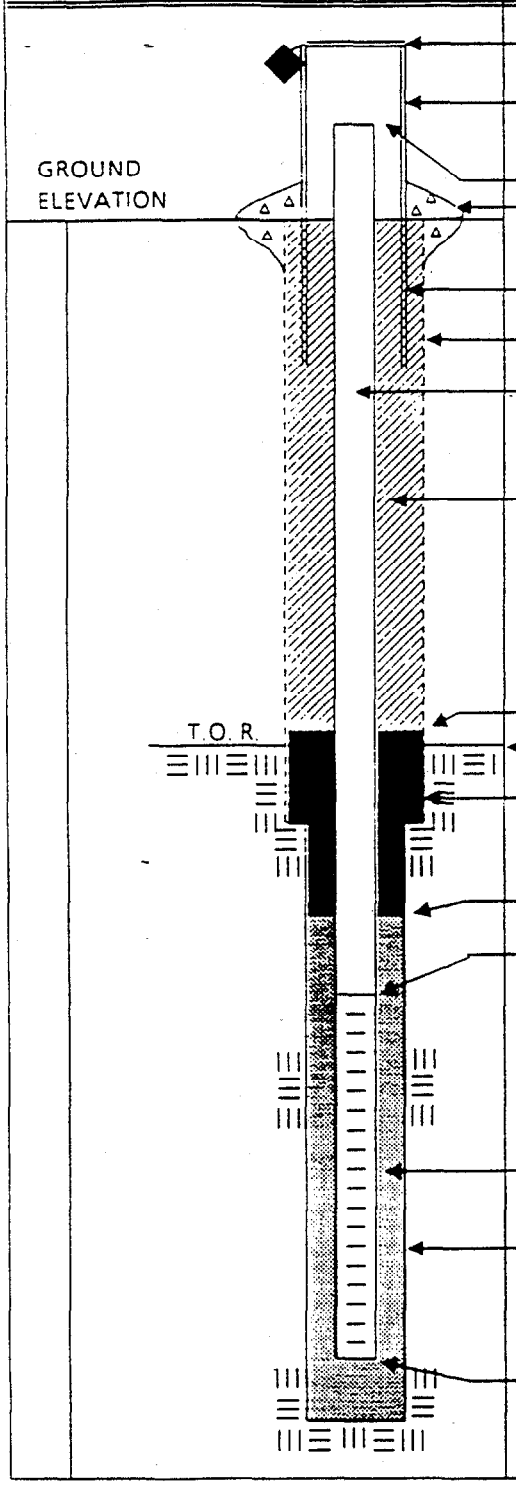
BEDROCK MONITORING WELL SHEET

WELL INSTALLED IN BEDROCK

PROJECT NAWC WARMINSTER
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST D. Whalen

LOCATION WARMINSTER PA
BORING HN-24S
DATE

DRILLER RAAB
DRILLING METHOD Air ROTARY
DEVELOPMENT METHOD SUB. PUMP



ELEVATION OF TOP OF SURFACE CASING:

STICK UP OF CASING ABOVE GROUND SURFACE:

ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement Grout

I.D. OF SURFACE CASING: 10-inch

DIAMETER OF HOLE: 6-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION / DEPTH TOP OF SEAL:

ELEVATION / DEPTH TOP OF BEDROCK: 8

TYPE OF SEAL: Bentonite

ELEVATION / DEPTH TOP OF SAND: 45

ELEVATION / DEPTH TOP OF SCREEN: 50

TYPE OF SCREEN: Sched 40 PVC

SLOT SIZE x LENGTH: .020-inch X 10ft

I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: 6-inch

ELEVATION / DEPTH BOTTOM SCREEN: 60

ELEVATION / DEPTH BOTTOM OF HOLE: 125

BACKFILLED w/ bentonite TO 65

NUS CORPORATION
A Halliburton Company

BORING NO.: HN-24I

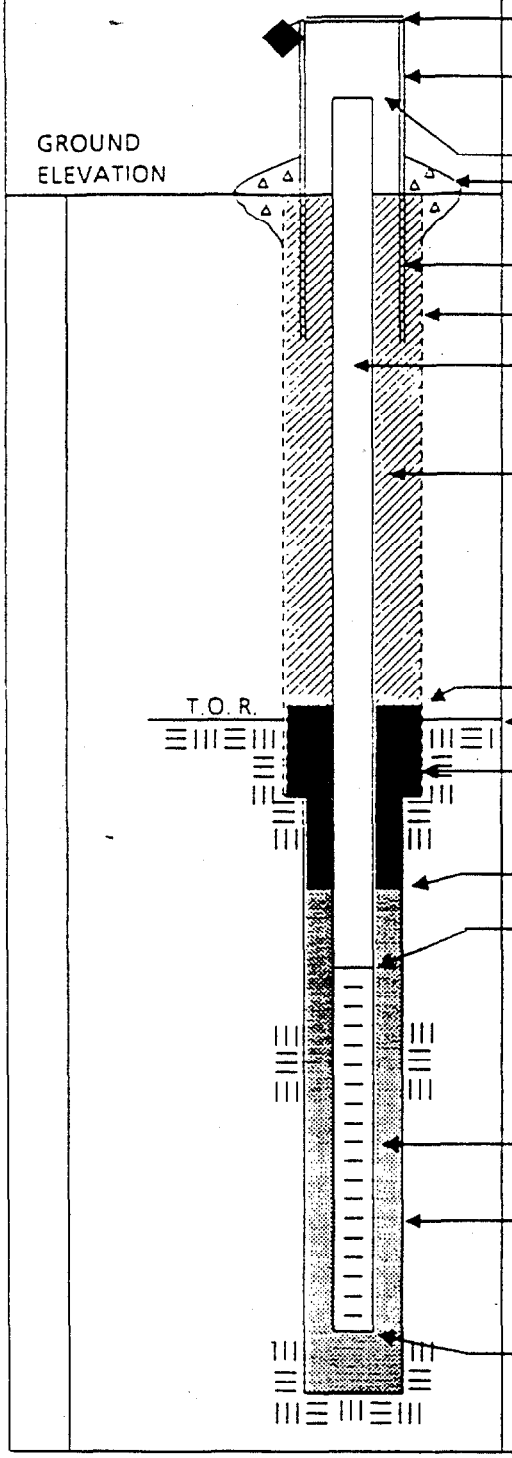
BEDROCK MONITORING WELL SHEET

WELL INSTALLED IN BEDROCK

PROJECT NAWC Warminster
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST R. Good

LOCATION Warminster Pa
BORING HN-24I
DATE

DRILLER RAAB
DRILLING METHOD Air Rotary
DEVELOPMENT METHOD Sub Pump



ELEVATION OF TOP OF SURFACE CASING:

STICK UP OF CASING ABOVE GROUND SURFACE:

ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement Grout

I.D. OF SURFACE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION / DEPTH TOP OF SEAL:

ELEVATION / DEPTH TOP OF BEDROCK: 8

TYPE OF SEAL: Bentonite

ELEVATION / DEPTH TOP OF SAND: 95

ELEVATION / DEPTH TOP OF SCREEN: 100

TYPE OF SCREEN: Sched 40 PVC

SLOT SIZE x LENGTH: .020-inch x 10ft

I.D. SCREEN:

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: 6-inch

ELEVATION / DEPTH BOTTOM SCREEN: 110

ELEVATION / DEPTH BOTTOM OF HOLE: 202

Backfilled w/ bentonite to 115

BORING NO.: HN-25S

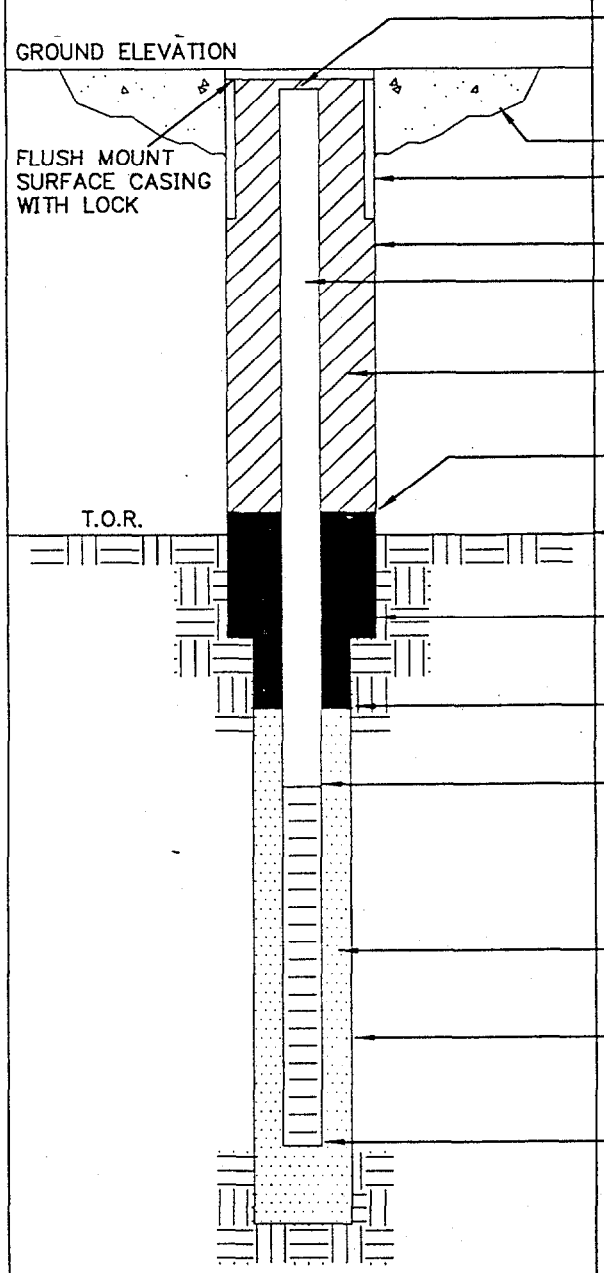
Halliburton NUS CORPORATION

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT NAWC WARMINSTER
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST K. KILMARTIN

LOCATION WARMINSTER PA
BORING HN-25S
DATE

DRILLER RAAB
DRILLING METHOD AIR ROTARY
DEVELOPMENT METHOD SUB PUMP



ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement

TYPE OF PROTECTIVE CASING: Steel

I.D. OF PROTECTIVE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION/DEPTH TOP OF SEAL:

ELEVATION/DEPTH TOP OF BEDROCK: 16

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: 26

ELEVATION/DEPTH TOP OF SCREEN: 30

TYPE OF SCREEN: Sched 40 PVC

SLOT SIZE x LENGTH: .020-inch x 15 feet

I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK: 6-inch

ELEVATION/DEPTH BOTTOM SCREEN: 45

ELEVATION/DEPTH BOTTOM HOLE: 145

Borehole backfilled with bentonite to 49 ft.

ACAD: C:JEFF.DWG 06/14/94 TD

Halliburton NUS CORPORATION

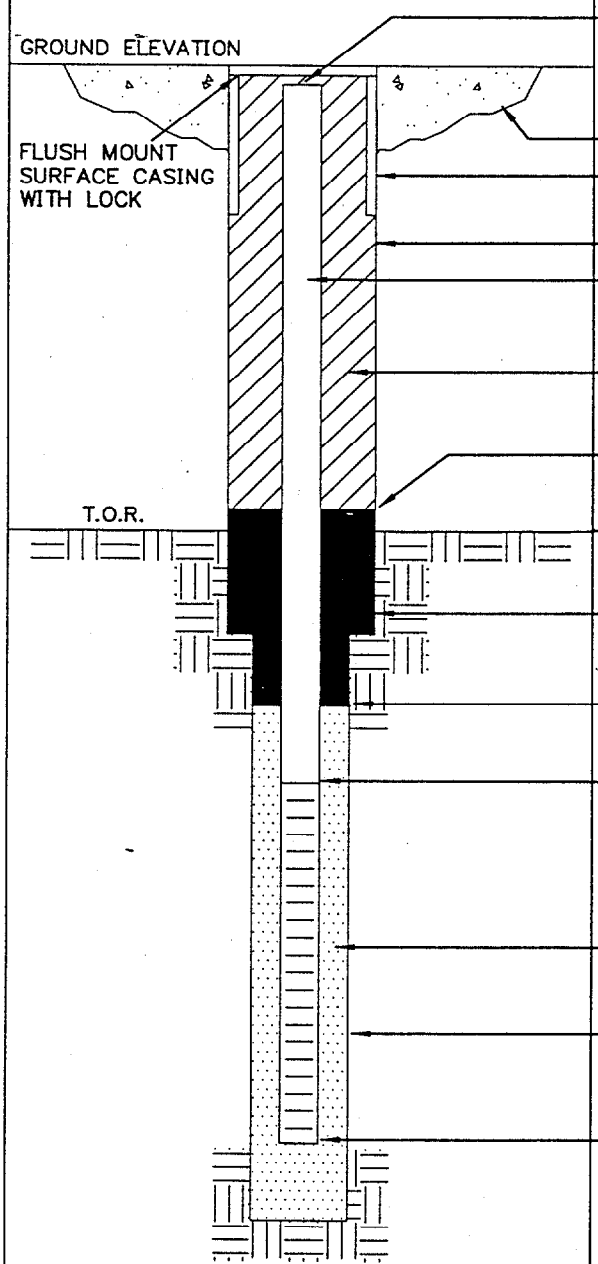
BORING NO.: HN-25 I

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT NAWC WARMINSTER
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST R. GOOD

LOCATION WARMINSTER PA
BORING HN-25 I
DATE

DRILLER RAAB
DRILLING METHOD AIR ROTARY
DEVELOPMENT METHOD SUB PUMP



ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement

TYPE OF PROTECTIVE CASING: Steel
I.D. OF PROTECTIVE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch
TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION/DEPTH TOP OF SEAL:

ELEVATION/DEPTH TOP OF BEDROCK: 16

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: 69

ELEVATION/DEPTH TOP OF SCREEN 73
TYPE OF SCREEN: Sched 40 PVC
SLOT SIZE x LENGTH: .020-inch x 10 FT
I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK: 6-inch

ELEVATION/DEPTH BOTTOM SCREEN: 83
ELEVATION/DEPTH BOTTOM HOLE: 83

ACAD: C:JEFF.DWG 06/14/94 TD

BORING NO.: HN-26S

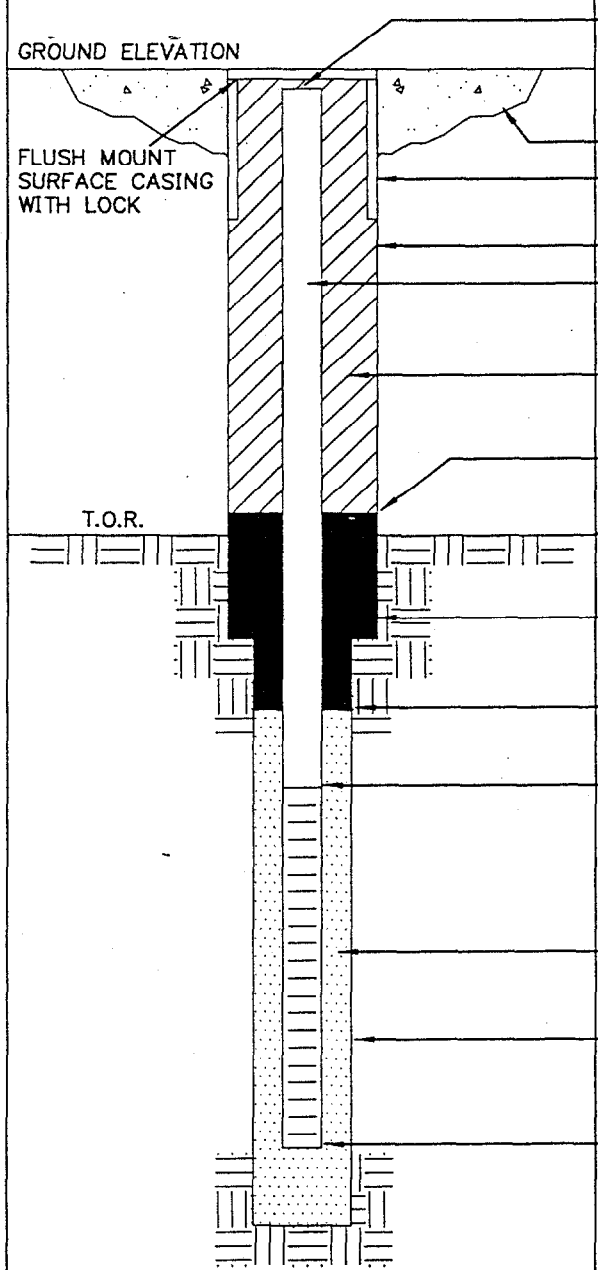
Halliburton NUS CORPORATION

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT NAWC WARMINSTER
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST D. Whalen

LOCATION Warminster PA
BORING HN-26S
DATE

DRILLER RAAB
DRILLING METHOD AIR ROTARY
DEVELOPMENT METHOD SUB. PUMP



ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement

TYPE OF PROTECTIVE CASING: Steel

I.D. OF PROTECTIVE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION/DEPTH TOP OF SEAL:

ELEVATION/DEPTH TOP OF BEDROCK: 8

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: 28

ELEVATION/DEPTH TOP OF SCREEN: 33

TYPE OF SCREEN: Sched 40 PVC

SLOT SIZE x LENGTH: .020-inch X 20 feet

I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK: 6-inch

ELEVATION/DEPTH BOTTOM SCREEN: 53

ELEVATION/DEPTH BOTTOM HOLE: 53

ACAD: C:JEFF.DWG 06/14/94 TD

BORING NO.: HN-26 I

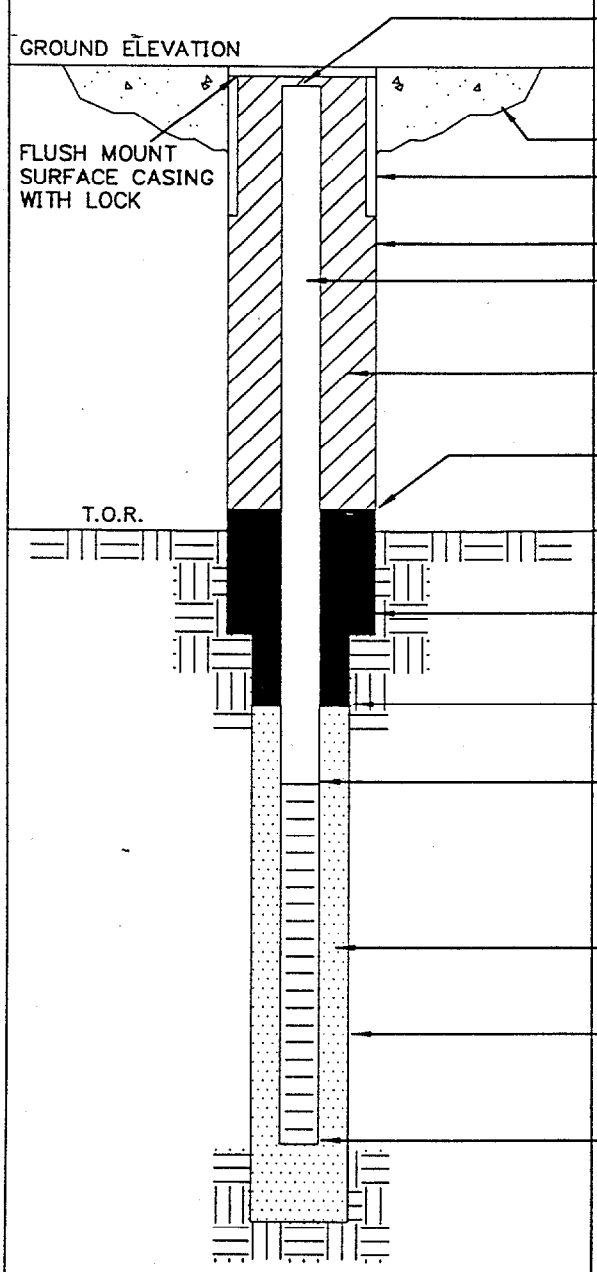
Halliburton NUS CORPORATION

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT NAWC Warminster
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST K. KILMARTIN

LOCATION WARMINSTER PA
BORING HN-26 I
DATE

DRILLER RAAB
DRILLING METHOD AIR ROTARY
DEVELOPMENT METHOD SUB. PUMP



ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement

TYPE OF PROTECTIVE CASING: Steel
I.D. OF PROTECTIVE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION/DEPTH TOP OF SEAL:

ELEVATION/DEPTH TOP OF BEDROCK: 8

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: 119

ELEVATION/DEPTH TOP OF SCREEN: 125
TYPE OF SCREEN: Sched 40 PVC
SLOT SIZE x LENGTH: .020-inch X 20 feet
I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK: 6-inch

ELEVATION/DEPTH BOTTOM SCREEN: 145
ELEVATION/DEPTH BOTTOM HOLE: 205

Borehole backfilled with bentonite to 151 ft.

ACAD: C:JEFF.DWG 06/14/94 TD

NUS CORPORATION
A Halliburton Company

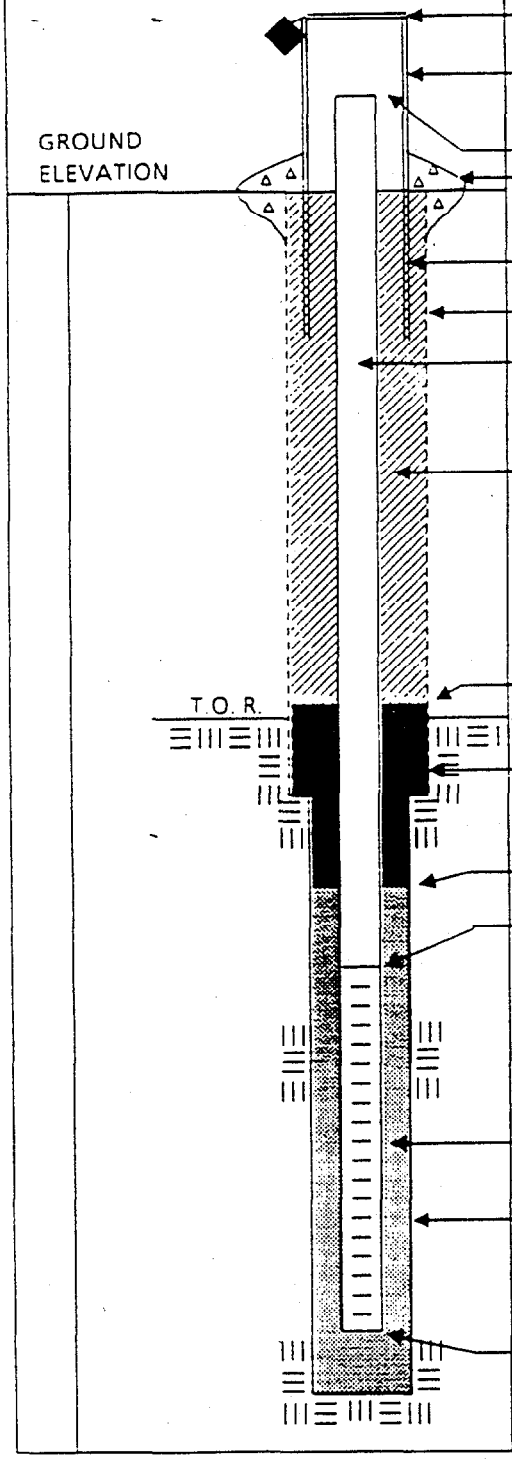
BORING NO.: HN-27S

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT NAWC Warminster
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST D. Whalen

LOCATION Warminster PA
BORING HN-27 S
DATE

DRILLER RAAB
DRILLING METHOD Air ROTARY
DEVELOPMENT METHOD SUB. PUMP



ELEVATION OF TOP OF SURFACE CASING:

STICK UP OF CASING ABOVE GROUND SURFACE:

ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement Grout

I.D. OF SURFACE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION / DEPTH TOP OF SEAL:

ELEVATION / DEPTH TOP OF BEDROCK: 8

TYPE OF SEAL: Bentonite

ELEVATION / DEPTH TOP OF SAND: 18

ELEVATION / DEPTH TOP OF SCREEN: 20

TYPE OF SCREEN: Sched 40 PVC

SLOT SIZE x LENGTH: .020-inch x 25 ft

I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: 6-inch

ELEVATION / DEPTH BOTTOM SCREEN: 45

ELEVATION / DEPTH BOTTOM OF HOLE: 103

Backfill with bentonite to 52 ft.

NUS CORPORATION
A Halliburton Company

BORING NO.: HN-27 I

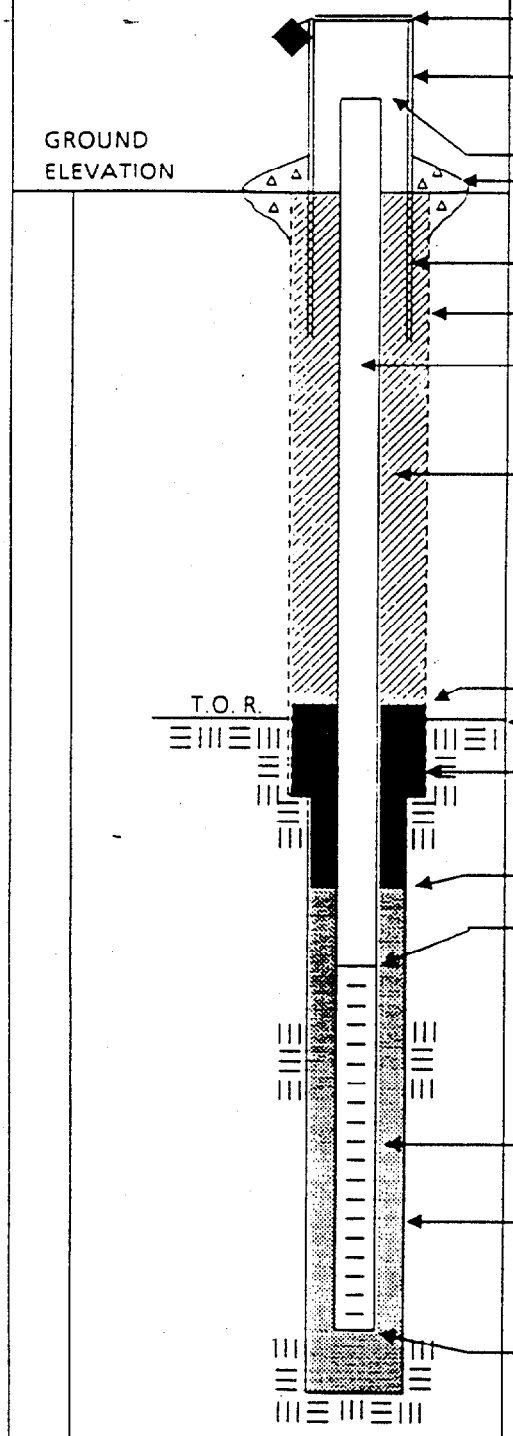
BEDROCK MONITORING WELL SHEET

WELL INSTALLED IN BEDROCK

PROJECT NAWC Warminster
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST D. Whalen

LOCATION Warminster PA
BORING HN-27 I
DATE

DRILLER RAAB
DRILLING METHOD Air Rotary
DEVELOPMENT METHOD Cent. Pump



ELEVATION OF TOP OF SURFACE CASING:

STICK UP OF CASING ABOVE GROUND SURFACE:

ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement Grout.

I.D. OF SURFACE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION / DEPTH TOP OF SEAL:

ELEVATION / DEPTH TOP OF BEDROCK: 8

TYPE OF SEAL: Bentonite

ELEVATION / DEPTH TOP OF SAND: 145

ELEVATION / DEPTH TOP OF SCREEN: 148

TYPE OF SCREEN: Sched 40 PVC

SLOT SIZE x LENGTH: .020-inch x 10 ft

I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: 6-inch

ELEVATION / DEPTH BOTTOM SCREEN: 158

ELEVATION / DEPTH BOTTOM OF HOLE: 158

NUS CORPORATION
A Halliburton Company

BORING NO.: HN-28 S

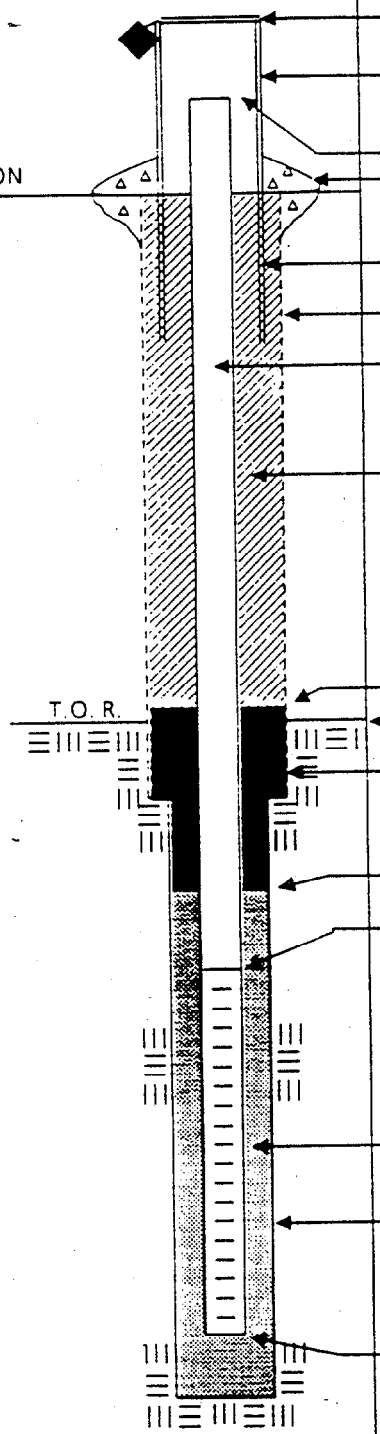
BEDROCK MONITORING WELL SHEET

WELL INSTALLED IN BEDROCK

PROJECT NAWC Warminster
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST K. KILMARTIN

LOCATION Warminster PA
BORING HN-28 S
DATE

DRILLER RAAB
DRILLING METHOD AIR ROTARY
DEVELOPMENT METHOD SUB. PUMP



ELEVATION OF TOP OF SURFACE CASING:

STICK UP OF CASING ABOVE GROUND SURFACE:

ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement Grout

I.D. OF SURFACE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched. 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION / DEPTH TOP OF SEAL:

ELEVATION / DEPTH TOP OF BEDROCK: 10

TYPE OF SEAL: Bentonite

ELEVATION / DEPTH TOP OF SAND: 53

ELEVATION / DEPTH TOP OF SCREEN: 56

TYPE OF SCREEN: Sched 40 PVC

SLOT SIZE x LENGTH: .020-inch X 10 ft.

I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: 6-inch

ELEVATION / DEPTH BOTTOM SCREEN: 66

ELEVATION / DEPTH BOTTOM OF HOLE: 84

Backfill with bentonite TO 68 ft.

NUS CORPORATION
A Halliburton Company

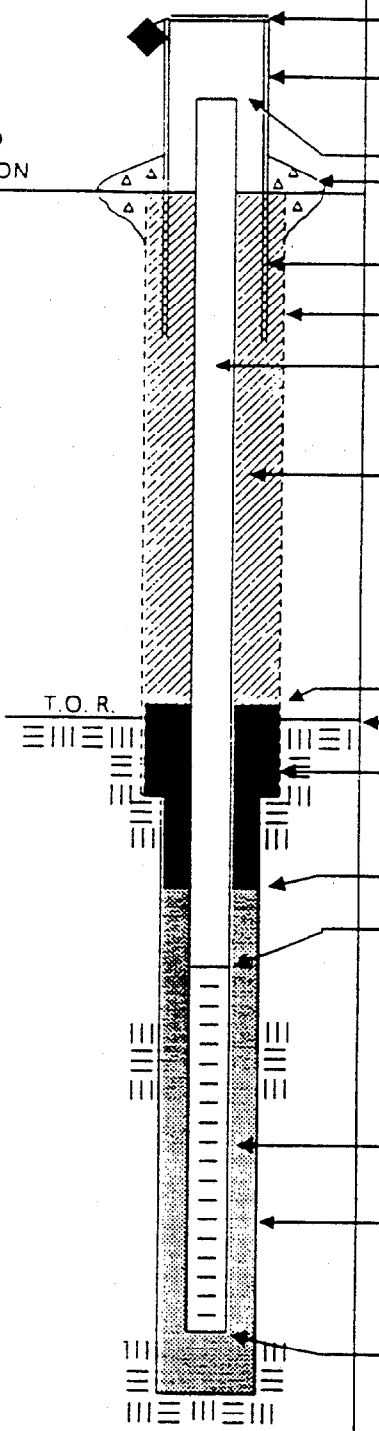
BORING NO.: HN-28I

BEDROCK MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT NAWC Warminster
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST D. Whalen

LOCATION Warminster PA
BORING HN-28I
DATE

DRILLER RAAB
DRILLING METHOD Air Rotary
DEVELOPMENT METHOD Natural (Artesian)



ELEVATION OF TOP OF SURFACE CASING:
STICK UP OF CASING ABOVE GROUND SURFACE:
ELEVATION TOP OF RISER:
TYPE OF SURFACE SEAL: Cement Grout
I.D. OF SURFACE CASING: 6-inch
DIAMETER OF HOLE: 10-inch
RISER PIPE I.D.: 2-inch
TYPE OF RISER PIPE: Sched 40 PVC
TYPE OF BACKFILL: Bentonite

ELEVATION / DEPTH TOP OF SEAL:
ELEVATION / DEPTH TOP OF BEDROCK: 10
TYPE OF SEAL: Bentonite

ELEVATION / DEPTH TOP OF SAND: 154
ELEVATION / DEPTH TOP OF SCREEN: 167
TYPE OF SCREEN: Sched 40 PVC
SLOT SIZE x LENGTH: .020-inch x 5 ft
I.D. SCREEN: 2-inch
TYPE OF SAND PACK: Pea gravel (159 to 172); #2 Morie equiv (154 to 159)
DIAMETER OF HOLE IN BEDROCK:
CORE / REAM: 6-inch

ELEVATION / DEPTH BOTTOM SCREEN: 172
ELEVATION / DEPTH BOTTOM OF HOLE: 184
Natural Collapse/backfill to 172

NUS CORPORATION
A Halliburton Company

BORING NO.: HN-29 S

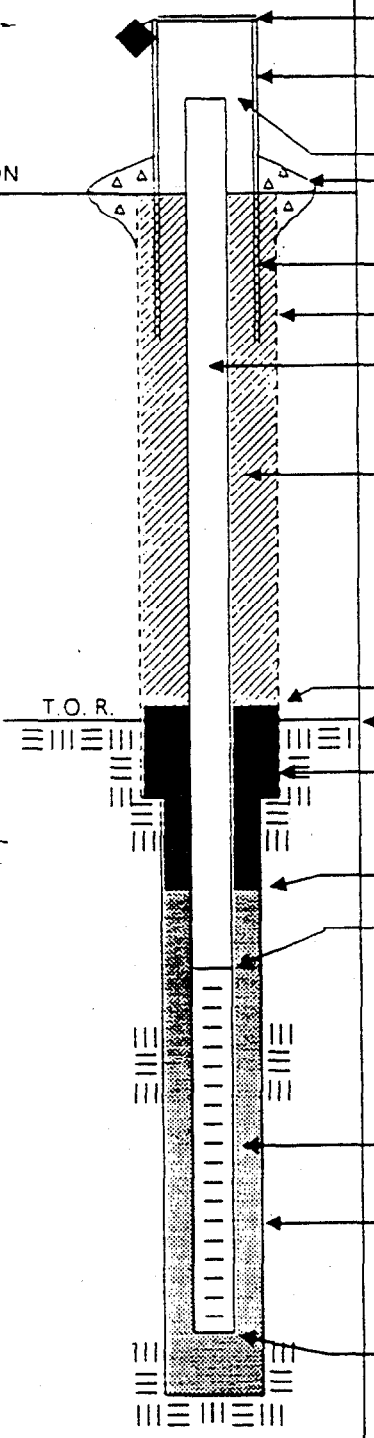
BEDROCK MONITORING WELL SHEET

WELL INSTALLED IN BEDROCK

PROJECT NAWC WARMINSTER
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST K. KILMARTIN

LOCATION Warminster PA
BORING HN-29 S
DATE

DRILLER RAAB
DRILLING METHOD AIR ROTARY
DEVELOPMENT METHOD SUB. PUMP



ELEVATION OF TOP OF SURFACE CASING:

STICK UP OF CASING ABOVE GROUND SURFACE:

ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement Grout

I.D. OF SURFACE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION / DEPTH TOP OF SEAL:

ELEVATION / DEPTH TOP OF BEDROCK: 8

TYPE OF SEAL: Bentonite

ELEVATION / DEPTH TOP OF SAND: 38

ELEVATION / DEPTH TOP OF SCREEN: 40

TYPE OF SCREEN: Sched 40 PVC

SLOT SIZE x LENGTH: .020-inch x 15 ft

I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: 6-inch

ELEVATION / DEPTH BOTTOM SCREEN: 55

ELEVATION / DEPTH BOTTOM OF HOLE: 65

Backfilled with bentonite to 59 ft.

NUS CORPORATION
A Halliburton Company

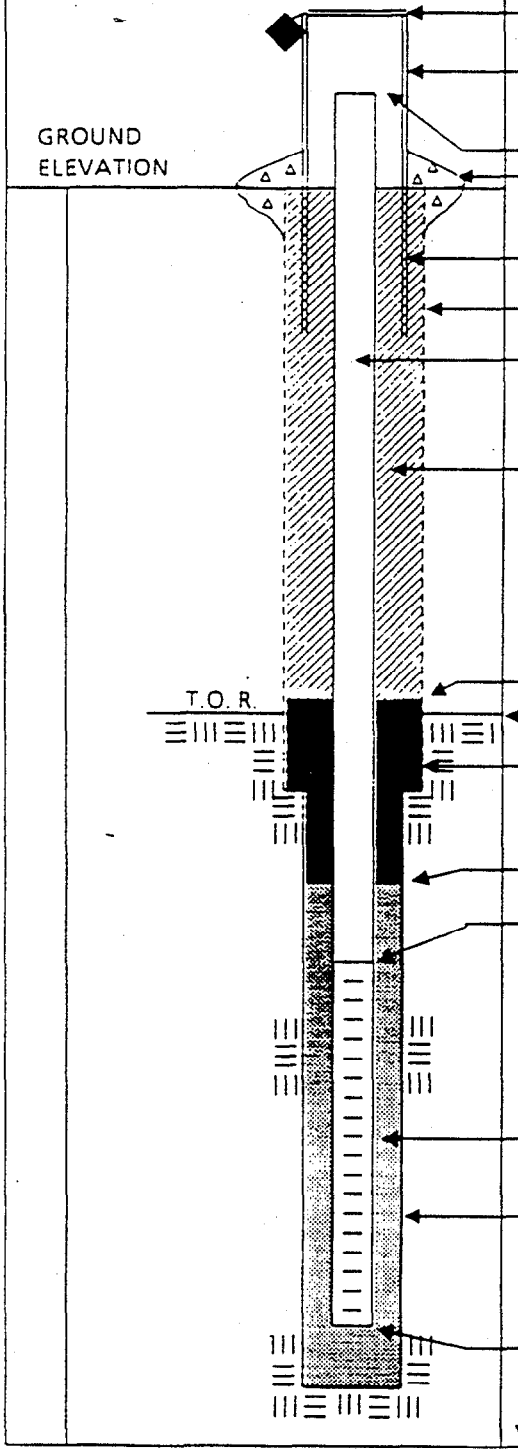
BORING NO.: HN-29I

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT: NAWC Warminster
PROJECT NO.: 1412
ELEVATION:
FIELD GEOLOGIST: D. Whalen

LOCATION: Warminster PA
BORING: HN-29I
DATE:

DRILLER: RAAB
DRILLING METHOD: Air Rotary
DEVELOPMENT METHOD: Natural (artesian)



ELEVATION OF TOP OF SURFACE CASING:

STICK UP OF CASING ABOVE GROUND SURFACE:

ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement Grout

I.D. OF SURFACE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch

TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION / DEPTH TOP OF SEAL:

ELEVATION / DEPTH TOP OF BEDROCK: 8

TYPE OF SEAL: Bentonite

ELEVATION / DEPTH TOP OF SAND: 122

ELEVATION / DEPTH TOP OF SCREEN: 125

TYPE OF SCREEN: Sched 40 PVC

SLOT SIZE x LENGTH: .020-inch X 10 ft.

I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK:

CORE / REAM: 6-inch

ELEVATION / DEPTH BOTTOM SCREEN: 135

ELEVATION / DEPTH BOTTOM OF HOLE: 145

BACKfilled with Bentonite to 148 ft.

HALLIBURTON NUS
Environmental Corporation

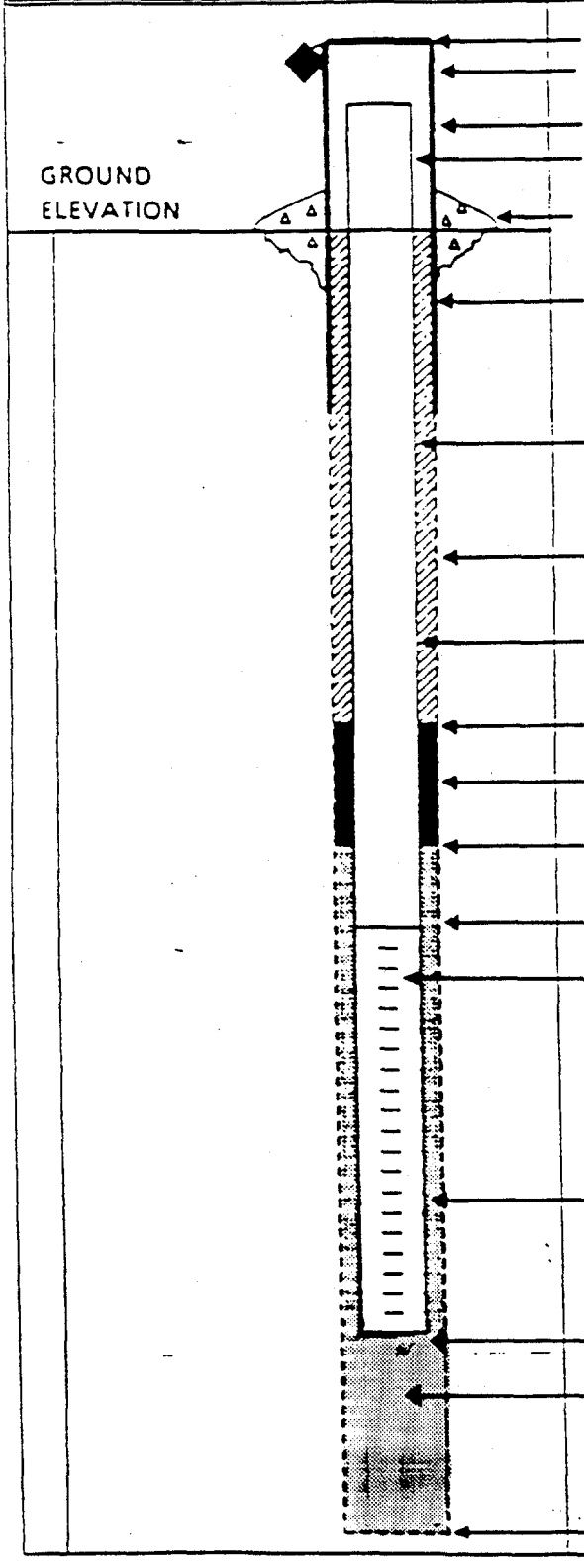
BORING NO HN-29X

OVERBURDEN MONITORING WELL SHEET

PROJECT NAWC WARMINSTER
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST D. Whalen

LOCATION WARMINSTER PA
BORING HN-29X
DATE

DRILLER RAAB
DRILLING METHOD AIR ROTARY
DEVELOPMENT METHOD CENT. PUMP



ELEVATION OF TOP OF SURFACE CASING:
ELEVATION OF TOP OF RISER PIPE:
STICK - UP TOP OF SURFACE CASING:
STICK - UP RISER PIPE:
TYPE OF SURFACE SEAL: Cement Grout
I.D. OF SURFACE CASING: 6-inch
TYPE OF SURFACE CASING: STEEL
RISER PIPE I.D. 2-inch
TYPE OF RISER PIPE: Sched 40 PVC
BOREHOLE DIAMETER: 6-inch
TYPE OF BACKFILL: bentonite
ELEVATION / DEPTH TOP OF SEAL:
TYPE OF SEAL: bentonite
DEPTH TOP OF SAND PACK: 4
ELEVATION / DEPTH TOP OF SCREEN: 5
TYPE OF SCREEN: Sched 40
SLOT SIZE x LENGTH: .020-inch x 5 ft
I.D. OF SCREEN: 2-inch
TYPE OF SAND PACK: #2 Morie Equiv.
ELEVATION / DEPTH BOTTOM OF SCREEN: 10
ELEVATION / DEPTH BOTTOM OF SAND PACK: 10
TYPE OF BACKFILL BELOW OBSERVATION WELL: N/A
ELEVATION / DEPTH OF HOLE: 10

Halliburton NUS CORPORATION

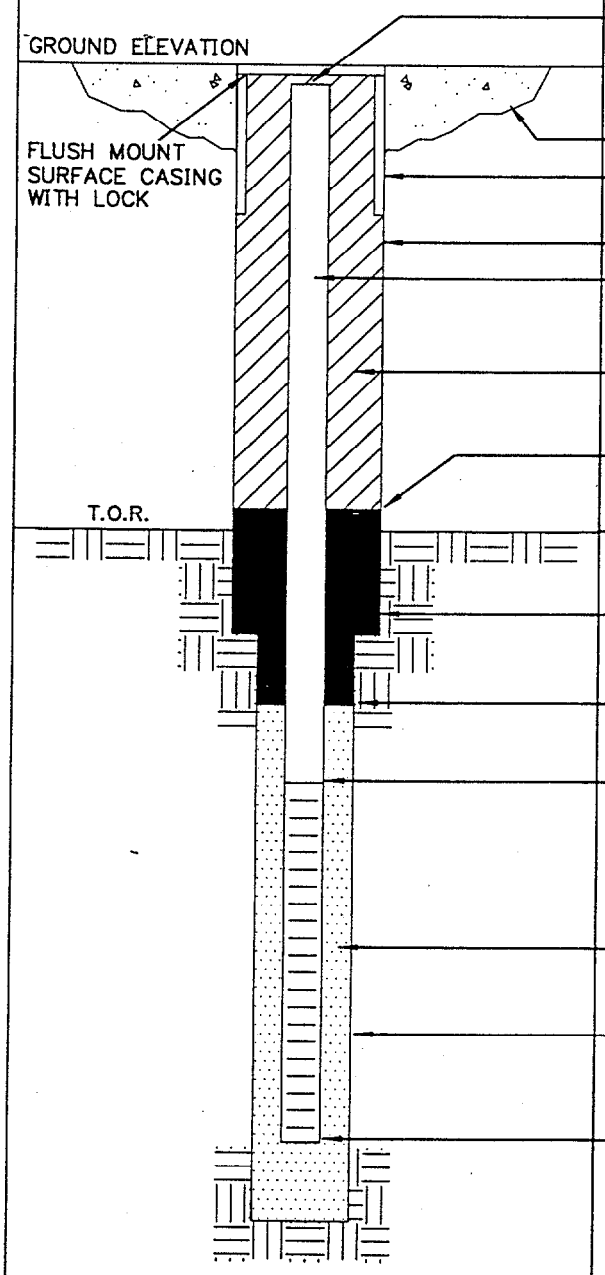
BORING NO.: HN-30S

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT NAWC Warminster
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST D. Whalen

LOCATION Warminster PA
BORING HN-30S
DATE

DRILLER RAAB
DRILLING METHOD Air Rotary
DEVELOPMENT METHOD Sub Pump



ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement

TYPE OF PROTECTIVE CASING: Steel
I.D. OF PROTECTIVE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch
TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION/DEPTH TOP OF SEAL:

ELEVATION/DEPTH TOP OF BEDROCK: 15

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: 68

ELEVATION/DEPTH TOP OF SCREEN 70
TYPE OF SCREEN: Sched 40 PVC
SLOT SIZE x LENGTH: .020-inch x 10 ft
I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK: 6-inch

ELEVATION/DEPTH BOTTOM SCREEN: 80
ELEVATION/DEPTH BOTTOM HOLE: 101

Borehole backfilled with bentonite to 83 ft.

ACAD: C:JEFF.DWG 06/14/94 TD

BORING NO.: HN-34S

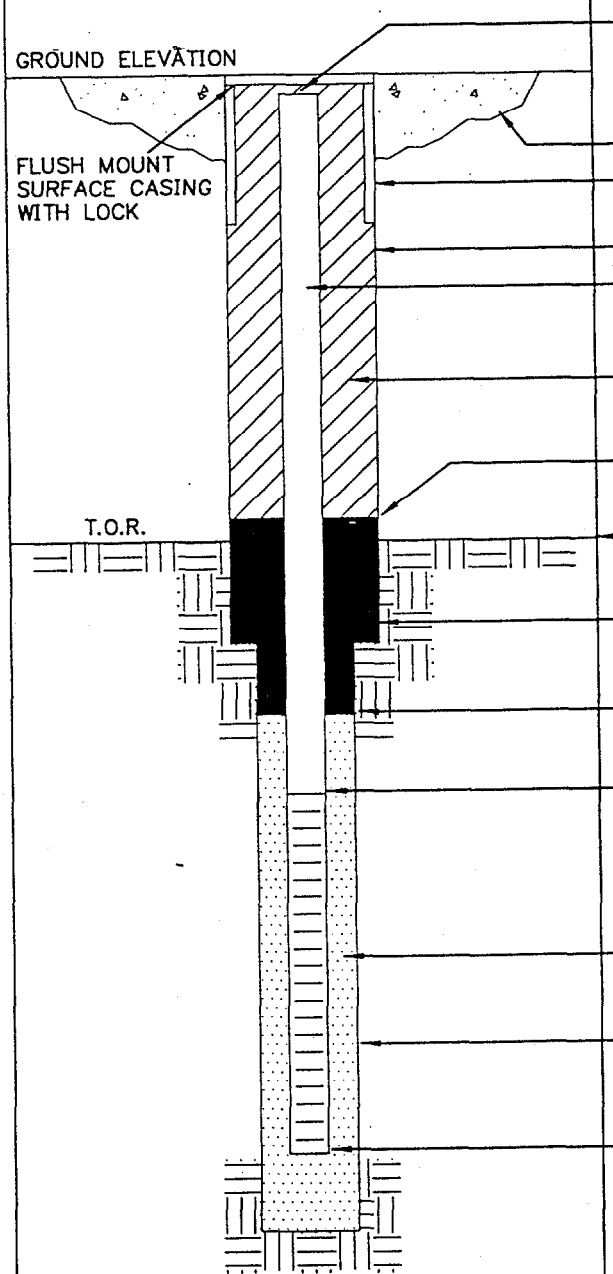
Halliburton NUS CORPORATION

BEDROCK
MONITORING WELL SHEET
WELL INSTALLED IN BEDROCK

PROJECT NAWC Warminster
PROJECT NO. 1412
ELEVATION
FIELD GEOLOGIST D Whalen

LOCATION WARMINSTER PA
BORING HN-34S
DATE

DRILLER RAAB
DRILLING METHOD AIR ROTARY
DEVELOPMENT METHOD SUB. PUMP



ELEVATION TOP OF RISER:

TYPE OF SURFACE SEAL: Cement

TYPE OF PROTECTIVE CASING: Steel
I.D. OF PROTECTIVE CASING: 6-inch

DIAMETER OF HOLE: 10-inch

RISER PIPE I.D.: 2-inch
TYPE OF RISER PIPE: Sched 40 PVC

TYPE OF BACKFILL: Bentonite

ELEVATION/DEPTH TOP OF SEAL:

ELEVATION/DEPTH TOP OF BEDROCK: 10

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: 87

ELEVATION/DEPTH TOP OF SCREEN: 90
TYPE OF SCREEN: Sched 40 PVC
SLOT SIZE x LENGTH: .020-inch X 10 ft
I.D. SCREEN: 2-inch

TYPE OF SAND PACK: #2 Morie equiv.

DIAMETER OF HOLE IN BEDROCK: 6-inch

ELEVATION/DEPTH BOTTOM SCREEN: 100
ELEVATION/DEPTH BOTTOM HOLE: 105

ACAD: C:JEFF.DWG 06/14/94 TD

APPENDIX C

WELL DEVELOPMENT LOGS

WELL NUMBER HN-26 S

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/18/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1545	2.5	CLOUDY WHITE; REDDISH TINT	NA *	NA *	240	138.3
1600	2.5	"			180	193.7
1615	2.5	SLIGHTLY CLOUDY, WHITE			170	101.3
1630	2.5	VERY SLIGHTLY CLOUDY			170	51.6
1645	2.5	"			170	31.3
1700	2.5	MOSTLY CLEAR			170	22.6

DEVELOPMENT METHOD: Submersible Pump

* pH/TEMP METER NOT WORKING

WELL NUMBER HN-26 I

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/18/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1425	3.0	Clear	NA*	NA*	195	5.22
1440	3.0	"			195	11.05
1455	2.5	"			200	3.99
1510	2.5	"			195	2.45
1525	2.5	"			200	1.77
1540	2.5	"			200	1.62

DEVELOPMENT METHOD: Submersible Pump

* pH/Temp meter not working

WELL NUMBER HN-27 I

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/18/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1302	2	Slightly Milky	11.4	5.68	560	0.94
1323	2	"	11.4	5.78	520	0.96
1337	2	Clear	11.4	5.58	510	0.6
1353	2	"	11.2	6.38	520	0.42
1407	2	"	11.4	6.42	510	
1417	2	"	11.7	6.39	520	

DEVELOPMENT METHOD: Centrifugal Pump

WELL NUMBER HN-27S

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/18/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1258	0.75	CLOUDY, MILKY BROWN	11.6	7.93	1400	>200
1316	0.75	"	11.3	5.09	440	>200
1332	0.75	"	11.5	5.35	500	>200
1350	0.75	MILKY BROWN	11.5	5.45	500	>200
1402	0.75	"	11.5	5.56	510	>200

DEVELOPMENT METHOD: Submersible Pump

WELL NUMBER HN-29 X

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/18/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1024		SLIGHT CLOUDY, BROWN	6.2	6.42	1200	12.13
1035		"	6.3	6.38	1100	4.39
1045		"	6.4	6.56	1000	16.30
1053		"	6.3	6.48	1100	14.20

DEVELOPMENT METHOD: Centrifugal Pump

WELL NUMBER HN-28 I

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/17/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1314		Clear	12.0	6.4	440	0.5
1337		"	11.4	6.6	410	0.4
1421		"	11.6	6.8	420	0.4

DEVELOPMENT METHOD: Artesian Flow

WELL NUMBER HN-29S

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: _____

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
0845	3.25	TAN, CLOUDY	10.0	6.45	590	>200
0910	"	Brown, Cloudy	12.5	6.10	550	198.3
0930	6.5	"	12.4	6.22	540	66.0
0940	6.5	Brown, Slightly Cloudy	12.8	6.07	590	34.5
0952	6.5	"	11.6	6.22	550	24.4
1002	6.5	"	11.9	6.10	540	14.4
1015	6.5	"	11.6	6.03	540	8.96

DEVELOPMENT METHOD: Submersible Pump

WELL NUMBER HN-29 I

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/17/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1318		Clear	12.3	6.6	450	1.45
1340		"	12.2	6.8	420	0.41
1426		"	12.1	6.9	420	0.50

DEVELOPMENT METHOD: ARTESIAN FLOW

WELL NUMBER HN-34 S

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/18/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1140	4	Clear	NA*	NA*	220	2.35
1155	3.5	"			240	0.76
1210	3	"			260	0.24
1225	3	"			260	0.45
1240	3	"			260	0.41

DEVELOPMENT METHOD: Submersible Pump

* pH/Temp meter not working

WELL NUMBER HN-23S

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/19/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
11 18	10	SLIGHTLY CLOUDY	11.3	6.86	360	66.3
11 30	10	"	11.6	6.94	320	13.13
1140	10	"	11.8	7.14	330	5.29
1150	10	VERY SLIGHTLY CLOUDY	11.8	7.28	335	3.32
1205	10	NEAR CLEAR	11.9	8.03	325	2.11

DEVELOPMENT METHOD: CENTRIFUGAL PUMP

WELL NUMBER HN-23 I

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/17/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1309		Clear	12.2	7.6	440	0.4
1333		"	11.3	6.8	400	0.7
1417		"	11.0	6.95	370	0.8
1512		"	11.3	6.9	405	0.5

DEVELOPMENT METHOD: Artesian Flow

WELL NUMBER HN-24 S

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/21/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
955	8 oz/ 21 sec	LT. brown, cloudy	11.2	6.35	500	>200
1010		"	10.7		480	>200
1025		"	10.7	6.12	450	>200
1040		Less cloudy	11.6	5.59	485	138.5
1100		"	12.3	6.53	495	93.0
1115		Milky-cloudy	12.3	6.52	465	72.5
1130	8 oz/ 22 sec	"	11.3	6.79	460	60.4
1140	1	brown, cloudy	12.3	6.88	520	>200
1145	Pumped Dry					

DEVELOPMENT METHOD: Pump

WELL NUMBER HN-24 I

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/17/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1555	1.5	White, cloudy	11.2	7.4	525	
1610	1.5	"	10.9	7.67	605	
1625	1.5	"	10.6	7.88	520	
1640	1	"	11.6	7.78	500	
1655	1	"	11.6	7.92	495	
1710	1	"	11.7	7.82	490	

DEVELOPMENT METHOD: Submersible Pump

Turbidity meter not operating.

WELL NUMBER HN-25S

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/21/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1306	<0.5	MILKY GRAY, CLOUDY	11.8	7.03	365	>200
1316	<0.5	MILKY TAN, CLOUDY	10.8	6.56	350	>200
1331	<0.5	TAN, CLOUDY	11.6	6.47	385	>200
1342	PUMPED DRY					
1452	1	LIGHT BROWN, CLOUDY	10.3	7.34	380	>200
1502	<0.5	TAN, CLOUDY	9.9	7.40	420	>200
1512	1		11.6	6.86	500	>200
1516	1	LESS CLOUDY	11.2	6.94	405	>200

DEVELOPMENT METHOD: PUMP

WELL NUMBER HN-25 I

WELL DEVELOPMENT LOG

SITE: NAWC WARMINSTER, PENNSYLVANIA DATE: 3/21/94

TIME	YIELD (GPM)	VISUAL (COLOR, ETC)	TEMP (°C)	pH	CONDUCT. (MMHO)	TURBIDITY (NTU)
1351	2	MEDIUM BROWN, CLOUDY	11.9	6.42	395	>200
1401	"	LESS CLOUDY	12.6	6.76	400	>200
1412	"	"	12.6	6.91	400	69.2
1423	"	"	12.5	6.98	395	42.8
1434	3	MODERATE CLOUDY, BROWN	12.5	6.75	390	172.5
1444	3	MEDIUM BROWN, CLOUDY	12.5	7.02	880?*	>200

DEVELOPMENT METHOD: PUMP

* questionable reading

APPENDIX D

SAMPLE LOG SHEETS

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

Page ____ of ____

☐ Monitoring Well Data
☐ Domestic Well Data
☒ Other Blank

Case # ____

By ____

Project Site Name NAVC Warminster Project Site Number 1412
NUS Source No. NV-TB-12 Source Location Trip Blank

	Purge Data				
Total Well Depth: N/A					
Well Casing Size & Depth: N/A	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Static Water Level: N/A					
One Casing Volume: N/A					
Start Purge (hrs.): N/A					
End Purge (hrs.): N/A					
Total Purge Time (min.): N/A					
Total Amount Purged (gal.): N/A					
Monitor Reading: No Reading from HNU.					
Purge Method: N/A					
Sample Method: N/A					
Depth Sampled: N/A					
Sample Date & Time: 4/7/94 1145	Sample Data				
	pH	S.C.	Temp. (°C)	Color & Turbidity	
Sampled By: C.M.					

Signature(s): [signature]

Type of Sample
- ☒ Low Concentration
- ☐ High Concentration
- ☒ Grab
- ☐ Composite
- ☐ Grab - Composite

Observations / Notes:
Lab Provided Trip Blanks Topped off, Bubbles removed from Bottle by C.M.

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	1365773754	1365773754
PCB/Pest	4°C	Date Shipped	4/7/94	4/7/94
		Time Shipped	1350	1350
		Lab	Ceimic Corp	Ceimic Corp
		Volume	120ml + 2-1L Amber	2-1L Poly

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

☐ Monitoring Well Data
☐ Domestic Well Data
☒ Other Blank

Page ____ of ____
Case # ____
By ____

Project Site Name: NAVC Warminster Project Site Number: 1412
NUS Source No.: LV-RB-11 Source Location: Rinsate Blank.

	Purge Data				
Total Well Depth: N/A					
Well Casing Size & Depth: N/A	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Static Water Level: N/A					
One Casing Volume: N/A					
Start Purge (hrs.): N/A					
End Purge (hrs.): N/A					
Total Purge Time (min.): N/A					
Total Amount Purged (gal.): N/A					
Monitor Reading: No Readings from HNU.					
Purge Method: N/A					
Sample Method: N/A					
Depth Sampled: N/A					

Sample Date & Time: 4/5/94 1700	Sample Data			
	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By: E.H.				

Signature(s): [signature]

Observations / Notes:
Collected through SS. Bailer using DI water.

Type of Sample
☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	966931 7943	966931 7943
PCB/Pest	4°C	Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Ceimic Corp	Ceimic Corp
		Volume	120ml + 2-1L Amber	2-1L Poly

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

Page _____ of _____

☐ Monitoring Well Data
☐ Domestic Well Data
☒ Other Blank

Case # _____

By _____

Project Site Name NAWC Warminster Project Site Number 1412
NUS Source No. W-FB-C1 Source Location Field Blank.

	Purge Data				
Total Well Depth: N/A					
Well Casing Size & Depth: N/A	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Static Water Level: N/A					
One Casing Volume: N/A					
Start Purge (hrs.): N/A					
End Purge (hrs.): N/A					
Total Purge Time (min.): N/A					
Total Amount Purged (gal.): N/A					
Monitor Reading: No Reading from HNU.					
Purge Method: N/A					
Sample Method: N/A					
Depth Sampled: N/A					

Sample Date & Time: 4/7/94 1128	Sample Data			
	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By: DW				

Signature(s):

Observations / Notes:
Field Blank of Tap Water Used in Recon.

Type of Sample
- ☒ Low Concentration
- ☐ High Concentration
- ☒ Grab
- ☐ Composite
- ☐ Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	1365773754	1365773754
PCB/Pest	4°C	Date Shipped	4/7/94	4/7/94
		Time Shipped	1350	1350
		Lab	Ceimic Corp	Ceimic Corp
		Volume	120ml + 2-1L Amber	2-1L Poly

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

Page 1 of 1

Case # _____

By _____

Project Site Name: NAWC Warminster Project Site Number: 1412

NUS Source No.: W-MW-06-28 Source Location: 06-28

Total Well Depth:	11.5
Well Casing Size & Depth:	4" casing
Static Water Level:	5.3
One Casing Volume:	4.05
Start Purge (hrs.):	1230
End Purge (hrs.):	1235
Total Purge Time (min.):	05
Total Amount Purged (gal.):	5
Monitor Reading:	No HNU reading above background
Purge Method:	4" Stainless Steel Bailer
Sample Method:	4" stainless steel Bailer
Depth Sampled:	
Sample Date & Time:	4/5/94 1117
Sampled By:	Eric Huss
Signature(s):	

Purge Data

Volume	pH	S.C.	Temp. (°C)	Color & Turbidity

Purged Dry

Sample Data

pH	S.C.	Temp. (°C)	Color & Turbidity
5.39	360	8.5°C	water was clear

Observations / Notes:

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Semi Volatiles	4°C	Tag #		
PCB / Pesticides	4°C			
Metals	HNO_3 4°C	AB #	9669317943	9669317943
Filtered Metals	HNO_3 4°C	Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Lemic Corporation	Lemic Corporation
		Volume	(2) 1 Liter Amber 120 ML	2 1 Liter Plastic

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

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Case # _____

By _____

Project Site Name NAWC Warminster Project Site Number 1417

NUS Source No. W-MW-DG-22 Source Location DG-22

Total Well Depth: 61.4	Purge Data				
Well Casing Size & Depth: 6" casing	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Static Water Level: 1.7					
One Casing Volume: 89.55					
Start Purge (hrs.): 1023			Purged		
End Purge (hrs.): 1029			Dry		
Total Purge Time (min.): 6					
Total Amount Purged (gal.): 90					
Monitor Reading: No HNU reading above background					
Purge Method: 4" Submersible Pump					
Sample Method: 4" Stainless Steel					
Depth Sampled:					
Sample Date & Time: 4/5/94 0903	Sample Data				
	pH	S.C.	Temp. (°C)	Color & Turbidity	
Sampled By: Eric Huss	8.08	420	10.2 °C	clear no odor	
Signature(s):	Observations / Notes:				

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
		AB #	9669317943	9669317943
		Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Ceimic Corporation	Ceimic Corporation
		Volume	120 ml	2 1-Liter Plastic

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

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- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

Case # _____

By _____

Project Site Name: NAWC Warminster Project Site Number: 1412

NUS Source No.: W-MW-DG15 Source Location: DG15

	Purge Data				
Total Well Depth: 22.9'	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Well Casing Size & Depth: 6" Steel					
Static Water Level: 7.5'					
One Casing Volume: 22.6 gal					
Start Purge (hrs.): 1138'					
End Purge (hrs.): 1141			Purged		
Total Purge Time (min.): 3					
Total Amount Purged (gal.): 31.7			Dry.		
Monitor Reading: NO Hnu Readings Above Background.					
Purge Method: Submers. Pump.					
Sample Method: SS. Bailer					
Depth Sampled:					

Sample Date & Time: 4/5/94 1035	Sample Data			
	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By: E.H.	4.93	560	10.1	clear.

Signature(s): [signature]

Observations / Notes:

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
		AB #	9669317943	9669317943
		Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Ceimic Corp.	Ceimic Corp
		Volume	120ml	2-1L. Poly

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

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- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

Case # _____

By _____

Project Site Name: NAWC Warminster Project Site Number: 1412

NUS Source No.: W-MW-DG-6 Source Location: DG-6

	Purge Data				
Total Well Depth: 20.3'	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Well Casing Size & Depth: 2" Steel					
Static Water Level: 7.3'					
One Casing Volume: 2.1 gal					
Start Purge (hrs.): 1036					
End Purge (hrs.): 1046					
Total Purge Time (min.): 10					
Total Amount Purged (gal.): 4					
Monitor Reading: NO HNU Reading Above Background.					
Purge Method: Hand Bail					
Sample Method: SS. Bailer					
Depth Sampled:					

Purged Dry

Sample Date & Time: 4/5/94 1047	Sample Data			
	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By: E.H.	5.14	540	10.1	Clear

Signature(s): [signature]

Observations / Notes:

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
		AB #	9669317943	9669317943
		Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Ceimic Corp.	Ceimic Corp
		Volume	120ml	2-1L. Poly

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

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Case # _____

By _____

Project Site Name NAWC Warminster Project Site Number 1412

NUS Source No. W-MW-DG-4 Source Location DG-4

Total Well Depth: 13.7	Purge Data					
Well Casing Size & Depth: 2" Diameter	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity	
Static Water Level: 1.6						
One Casing Volume: 1.94						
Start Purge (hrs.): 1007						
End Purge (hrs.): 1010			Recovered			
Total Purge Time (min.): 3						
Total Amount Purged (gal.): 2.5						
Monitor Reading: No HNU readings above background						
Purge Method: 2" stainless steel bailer						
Sample Method: 2" stainless steel bailer						
Depth Sampled:						
Sample Date & Time: 4/5/94 0855	Sample Data					
	pH	S.C.	Temp. (°C)	Color & Turbidity		
Sampled By: Eric Huss	8.17	380	8.2			
Signature(s):	Observations / Notes:					

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO3 4°C	Tag #		
Filtered Metals	HNO3 4°C			
		AB #	9669317943	9669317943
		Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Ceimic Corporation	Ceimic Corporation
		Volume	120 ML	2 Liter Plastic

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

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☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other _____

Case # _____

By _____

Project Site Name: NAWC Warminster
Project Site Number: 1412
NUS Source No.: W-MW-BE-5
Source Location: BE-5

	Purge Data				
Total Well Depth: 48.6					
Well Casing Size & Depth: 6"	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
		10.69	260.	14.2	
Static Water Level: 14.3		11.72	220	14.3	
One Casing Volume: 45.3		12.10	210	14.3	
Start Purge (hrs.): 1037 1041 1115		12.23	220	14.4	
End Purge (hrs.): 1031 1105 1150					
Total Purge Time (min.): 62					
Total Amount Purged (gal.): 165					
Monitor Reading: No HNu Readings Above Background					
Purge Method: Submersible Pump					
Sample Method: S.S. Bailer					
Depth Sampled:					

Sample Date & Time: 4/7/94 1037	Sample Data			
	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By: E.H.		210	13.7	

Signature(s): [signature]

Observations / Notes:

Type of Sample
☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
		AB # 1	1365773754	1365773754
		Date Shipped	4/7/94	4/7/94
		Time Shipped	1350	1350
		Lab	Ceimic Corp.	Ceimic Corp.
		Volume	120ml	2-1L Poly

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

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- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

Case # _____

By _____

Project Site Name: NAWC Warminster Project Site Number: 1412

NUS Source No.: W-MW-MW2 Source Location: MW-1

Total Well Depth: 90.6	Purge Data				
Well Casing Size & Depth: 6" Steel	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
			270	13.4	
Static Water Level: 11.7			280	13.4	
One Casing Volume: 103.3 gal			280	13.4	
Start Purge (hrs.): 0823			290	13.5	
End Purge (hrs.): 1010					
Total Purge Time (min.): 107					
Total Amount Purged (gal.): 321					
Monitor Reading: no HNu Readings Above Background					
Purge Method: Submers. Pump					
Sample Method: S.S. Bailer					
Depth Sampled:					
Sample Date & Time: 4/7/94 1055	Sample Data				
	pH	S.C.	Temp. (°C)	Color & Turbidity	
Sampled By: CM		210	13.7		

Signature(s): [signature]

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Observations / Notes:
Sample is Duplicate of MW-MW1 assigned the time of 0835 on the Chain of Custody

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
		AB #	1365773754	1365773754
		Date Shipped	4/7/94	4/7/94
		Time Shipped	1350	1350
		Lab	Ceimic Corp.	Ceimic Corp.
		Volume	120ml	2-1L Poly

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Environmental Corporation

SAMPLE LOG SHEET

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- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

Case # _____

By _____

Project Site Name NAWC Warminster Project Site Number 1412

NUS Source No. W-MW-HW34S Source Location HW34S

	Purge Data				
Total Well Depth: 100.7	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Well Casing Size & Depth: 2" PVC			365	13.4	
Static Water Level: 14.91'			360	13.5	
One Casing Volume: 12.3 gal			360	13.5	
Start Purge (hrs.): 0741					
End Purge (hrs.): 0800					
Total Purge Time (min.): 19.0					
Total Amount Purged (gal.): 76					
Monitor Reading: No HNu Readings Above Background					
Purge Method: Submersible Pump					
Sample Method: S.S. Bailer					
Depth Sampled:					

Sample Date & Time:	Sample Data			
4/7/94 0945	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By: DW		390	10.1	

Signature(s): Donald W Kahler

Observations / Notes:

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB # 1	1365773754	1365773754
PCB/Pest	4°C	Date Shipped	4/7/94	4/7/94
		Time Shipped	1350	1350
		Lab	Ceimic Corp.	Ceimic Corp.
		Volume	120ml + 2-1L Amber	2-1L Poly

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Environmental Corporation

SAMPLE LOG SHEET

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- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

Case # _____

By _____

Project Site Name NAWC Warminster Project Site Number 1412

NUS Source No. W-MW-HN29I Source Location HN29I

	Purge Data				
Total Well Depth: 137.5'					
Well Casing Size & Depth: 2" PVC	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
		7.62	280	11.3	
Static Water Level: 0.0'		7.59	280	11.7	
One Casing Volume: 22.4 gal		7.69	280	11.4	
Start Purge (hrs.): 1151					
End Purge (hrs.): 1220					
Total Purge Time (min.): 29					
Total Amount Purged (gal.): 174					
Monitor Reading: NO HNU Reading Above Background.					
Purge Method: Freeflow Artesian					
Sample Method: SS. Bailer					
Depth Sampled:					
Sample Date & Time: 4/5/94 1150	Sample Data				
	pH	S.C.	Temp. (°C)	Color & Turbidity	
Sampled By: D.W.	8.62	370	12.0		

Signature(s): Donald Whalen

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Observations / Notes:

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	9669317943	9669317943
PCB/Pest.	4°C	Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Ceimic Corp.	Ceimic Corp
		Volume	120ml/2-1L Amber	2-1L. Poly

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Environmental Corporation

SAMPLE LOG SHEET

- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

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Case # _____

By _____

Project Site Name NAWC Warminster Project Site Number 1412

NUS Source No. W-MW-HN29X Source Location HN29X

	Purge Data				
Total Well Depth: 9.1'	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Well Casing Size & Depth: 2" PVC		6.77	380	7.3	
Static Water Level: 6.1'		6.86	380	7.0	
One Casing Volume: 1 gal		6.68	380	6.9	
Start Purge (hrs.): 1222					
End Purge (hrs.): 1231					
Total Purge Time (min.): 9					
Total Amount Purged (gal.): 5.					
Monitor Reading: NO HNU Reading Above Background.					
Purge Method: Hand Bail					
Sample Method: SS. Bailer					
Depth Sampled:					

Sample Date & Time: 4/5/94 1105	Sample Data			
	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By: DW	8.03	540	8.2	

Signature(s): Donald Whalen

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Observations / Notes:

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	9669317943	9669317943
Pest/PCB	4°C	Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Ceimic Corp.	Ceimic Corp
		Volume	120ml + 2-1L Amber	2-1L. Poly

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Environmental Corporation

SAMPLE LOG SHEET

- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

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Case # _____

By _____

Project Site Name: NAWC Warminster Project Site Number: 1412

NUS Source No.: W-MW-HN28S Source Location: HN28S

	Purge Data				
Total Well Depth: 67.6'	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Well Casing Size & Depth: 2" PVC					
Static Water Level: 2.3'					
One Casing Volume: 10.6 gal					
Start Purge (hrs.): 1428 + 1440					
End Purge (hrs.): 1431 + 1441					
Total Purge Time (min.): 4					
Total Amount Purged (gal.): 12					
Monitor Reading: NO HNU Reading Above Background.					
Purge Method: Submersy Pump					
Sample Method: SS. Bailer					
Depth Sampled:					

Purged Dry

Sample Date & Time: 4/5/94 1337	Sample Data			
	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By: G.D.	4.96	380	10.2	Clear

Signature(s): Gregory DeGroeyter

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Observations / Notes:

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	9669317943	9669317943
PCB/Pest	4°C	Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Ceimic Corp.	Ceimic Corp
		Volume	1 70ml + 2-1L Amber	2-1 L. Poly

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SAMPLE LOG SHEET

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☒ Monitoring Well Data
☐ Domestic Well Data
☐ Other _____

Case # _____

By _____

Project Site Name: NAWC Warminster
Project Site Number: 1412
NUS Source No.: W-MW-HV275
Source Location: HV275

Total Well Depth:	55
Well Casing Size & Depth:	2" PVC
Static Water Level:	12.8
One Casing Volume:	6.9 gal
Start Purge (hrs.):	0852 0906
End Purge (hrs.):	0855 0909
Total Purge Time (min.):	6
Total Amount Purged (gal.):	12
Monitor Reading:	No Hnu Readings Above Background
Purge Method:	Submersible Pump
Sample Method:	S.S. Bailer
Depth Sampled:	
Sample Date & Time:	4/7/94 0840
Sampled By:	G.D.
Signature(s):	[signature]

Purge Data

Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
		Pumped Bailer		

Sample Data

pH	S.C.	Temp. (°C)	Color & Turbidity
	~~400~~ 366	~~10.6~~ 11.3	Slight Cloudy

Observations / Notes:

Type of Sample
☒ Low Concentration
☐ High Concentration
☒ Grab
☐ Composite
☐ Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	1365773754	1365773754
PCB/Pest	4°C	Date Shipped	4/7/94	4/7/94
		Time Shipped	1350	1350
		Lab	Ceimic Corp.	Ceimic Corp.
		Volume	120ml & 2-1L Amber	2-1L Poly

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SAMPLE LOG SHEET

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- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

Case # _____

By _____

Project Site Name NAWC Warminster Project Site Number 1412

NUS Source No. W-MW-HN265 Source Location HN265

	Purge Data				
Total Well Depth: 46.4	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Well Casing Size & Depth: 2" PVC			330	14.2	
Static Water Level: 10.2			220	14.2	
One Casing Volume: 5.8 gal			220	14.2	
Start Purge (hrs.): 1222			210	14.2.	
End Purge (hrs.): 1315					
Total Purge Time (min.): 53					
Total Amount Purged (gal.): 25					
Monitor Reading: No Hnu Readings Above Background					
Purge Method: SS Bailer					
Sample Method: SS Bailer					
Depth Sampled:					

Sample Date & Time: 4/7/94 1029	Sample Data			
	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By: DW		240	9.6	Slightly Cloudy

Signature(s): Donald Whalen

Observations / Notes:

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	1365773754	1365773754
PCB/Pest	4°C	Date Shipped	4/7/94	4/7/94
		Time Shipped	1350	1350
		Lab	Ceimic Corp.	Ceimic Corp.
		Volume	120ml. 2-1L Amber	2-1L Poly

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SAMPLE LOG SHEET

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- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

Case # _____

By _____

Project Site Name: NAWC Warminster Project Site Number: 1412

NUS Source No.: W-MW-HN255 Source Location: HN 255

	Purge Data				
Total Well Depth: 45.1'	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Well Casing Size & Depth: 2" PVC					
Static Water Level: 7.0'					
One Casing Volume: 6.2 gal					
Start Purge (hrs.): 1002					
End Purge (hrs.): 1007					
Total Purge Time (min.): 5					
Total Amount Purged (gal.): 1.5					
Monitor Reading: NO HNU Reading Above Background.					
Purge Method: Submersible Pump					
Sample Method: SS. Bailer					
Depth Sampled:					

Sample Date & Time: 4/5/94 0945	Sample Data			
	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By: DW	8.08	360	10.6	

Signature(s): Donald Wilder

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Observations / Notes:

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	9669317943	9669317943
		Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Ceimic Corp.	Ceimic Corp
		Volume	120ml + 1L Amber	2-1L. Poly

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SAMPLE LOG SHEET

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- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

Case # _____

By _____

Project Site Name: NAWC Warminster Project Site Number: 1412

NUS Source No.: W-MW-HN24F Source Location: HN24F

Total Well Depth: 110.0'	Purge Data				
Well Casing Size & Depth: 2" PVC	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
		7.92	445	12.6	Pale Green
Static Water Level: 9.4'		7.85	475	12.5	Cloudy
One Casing Volume: 16.4 gal		7.74	420	12.6	
Start Purge (hrs.): 1531		7.74	420	12.6	
End Purge (hrs.): 1601					
Total Purge Time (min.): 30					
Total Amount Purged (gal.): 51.0					
Monitor Reading: NO Hnu Reading Above Background.					
Purge Method: Submers. Pump					
Sample Method: SS. Bailer					
Depth Sampled:					
Sample Date & Time: 4/5/94 1500	Sample Data				
	pH	S.C.	Temp. (°C)	Color & Turbidity	
Sampled By: GD	8.06	470	12.5		

Signature(s): Gregory DeGoursey

Observations / Notes:

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	9669317943	9669317943
PCB/Pest	4°C	Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Ceimic Corp.	Ceimic Corp
		Volume	120ml + 2-1L Amber	2-1L. Poly

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

Page _____ of _____

Case # _____

By _____

Project Site Name: NAWC Warminster Project Site Number: 1412

NUS Source No.: WMW-HW23I Source Location: HW23E

Total Well Depth: 153.8	**Purge Data**				
Well Casing Size & Depth: 2" PVC	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
		7.78	300.	12.5	
Static Water Level: 10.0		7.18	340	12.3	
One Casing Volume: 14.6 gal		7.18	340	12.4	
Start Purge (hrs.): 1457		7.22	340	12.3	
End Purge (hrs.): 1520					
Total Purge Time (min.): 23					
Total Amount Purged (gal.): 184					
Monitor Reading: NO HNU readings Above Back ground					
Purge Method: Free Flow Artesian					
Sample Method: SS. Bailer					
Depth Sampled:					
Sample Date & Time: 4/5/94 1320	**Sample Data**				
	pH	S.C.	Temp. (°C)	Color & Turbidity	
Sampled By: DCW	7.68	330	12.0		

Signature(s): Donald Whaler

Observations / Notes: Triple Volume Collected for Sample to be MS/MSD.

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	9669317943	9669317943
PCB/Pest	4°C	Date Shipped	4/5/93	4/5/93
		Time Shipped	1915	1915
		Lab	Celmic Corp	Celmic Corp
		Volume	360ml + 6-1L Ambers	6-1L Poly

HALLIBURTON NUS
Environmental Corporation

SAMPLE LOG SHEET

Page 1 of 1

- [x] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other _____

Case # _____

By _____

Project Site Name: NAWC Warminster Project Site Number: 1412

NUS Source No.: W-MW-HN235 Source Location: HN235

	Purge Data				
Total Well Depth: 63.2	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Well Casing Size & Depth: 2" PVC		7.65	320.	12.85	
Static Water Level: 6.4		7.23	310	12.75	
One Casing Volume: 9.1 gal		7.20	305	12.70	
Start Purge (hrs.): 1500					
End Purge (hrs.): 1515					
Total Purge Time (min.): 15					
Total Amount Purged (gal.): 90					
Monitor Reading: No HNU Reading Above Background.					
Purge Method: Submers. Pump					
Sample Method: SS. Bailer					
Depth Sampled:					

Sample Date & Time: 4/5/94 1257	Sample Data			
	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By: DW	7.03	300	12.1	clear

Signature(s): Donald Whalen

Observations / Notes:

Type of Sample
- [x] Low Concentration
- [ ] High Concentration
- [x] Grab
- [ ] Composite
- [ ] Grab - Composite

Analysis:	Preservative		Organic	Inorganic
VOA	HCl 4°C	Traffic Report #		
Metals	HNO_3 4°C	Tag #		
Filtered Metals	HNO_3 4°C			
BNA	4°C	AB #	9669317943	9669317943
PCB/Pest	4°C	Date Shipped	4/5/94	4/5/94
		Time Shipped	1915	1915
		Lab	Ceimic Corp.	Ceimic Corp
		Volume	120ml/2-1L Amber	2-1L. Poly

APPENDIX E

ANALYTICAL RESULTS

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-MW-DG-24		W-MW-DG-2B		W-MW-DG-4		W-MW-DG-5		W-MW-DG-6	
LABORATORY ID			940275-09		940275-10		940275-03		940275-04		940275-05	
TAL AQUEOUS TOTAL METALS (ug/L)												
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	171		453		366		999		639	
ANTIMONY	60.0	34.0	34.0	UL	34.0	UL	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.0	U	3.0	U	3.2		3.2		3.0	U
BARIUM	200	7.0	244	J	76.3	J	593	J	182	J	250	J
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.2	K	3.3	K	3.0	U	3.0	U
CALCIUM	5000	7.0	64900	J	30100	J	27000	J	60100	J	56300	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	8.0	K	7.0	U
COBALT	50.0	4.0	4.0	UL	4.0	U	4.0	U	4.0	UL	4.0	UL
COPPER	25.0	6.0	6.0	U	9.6		7.7		14.4		7.0	
IRON	100	5.0	204	J	572	J	35200	J	12500	J	17300	J
LEAD	3.0	1.0	1.0	U	1.0	U	3.2		3.2		3.5	
MAGNESIUM	5000	27.0	9500	J	10600	J	6820	J	12000	J	8980	J
MANGANESE	15.0	1.0	165		81.0		1030		1180		547	
MERCURY	0.20	0.10	0.14	U	0.13	U	0.13		0.13	U	0.15	
NICKEL	40.0	7.0	7.0	U	7.0	U	14.4	B	9.0	B	10.1	B
POTASSIUM	5000	10.0	971	J	877	J	1330	J	1180	J	1230	J
SELENIUM	5.0	4.0	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	11300	J	6690	J	10800	J	14000	J	10200	J
THALLIUM	10.0	4.0	4.0	UL	4.0	U	4.0	U	4.0	UL	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	8.6	B	5.2	B	5.4	B
ZINC	20.0	3.0	16.8	B	7.5	B	51.0	B	19.9	B	225	J

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-MW-HN-23I		W-MW-HN-23S		W-MW-HN-23X		W-MW-HN-24I		W-MW-HN-24S	
LABORATORY ID:			940275-11		940275-12		940275-13		940275-14		940275-15	
TAL AQUEOUS TOTAL METALS (ug/L)												
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	104		171		11600		33.0	U	138	
ANTIMONY	60.0	34.0	34.0	UL	34.0	UL	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.2		3.0	U	3.5		5.2		4.1	
BARIUM	200	7.0	235	J	275	J	219	J	181	J	292	J
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.1		1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.8	K	3.0	U	3.0	U
CALCIUM	5000	7.0	25300	J	28300	J	38600	J	35400	J	48400	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	13.4	K	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	UL	4.0	U	16.5		4.0	U	4.0	UL
COPPER	25.0	6.0	6.0	U	13.4		16.0		6.0	U	6.0	U
IRON	100	5.0	78.8	B	155	B	12500	J	49.8	B	105	B
LEAD	3.0	1.0	1.0	U	1.3		6.0		1.0	U	1.0	U
MAGNESIUM	5000	27.0	15600	J	7620	J	19900	J	12100	J	17900	J
MANGANESE	15.0	1.0	4.4	B	13.6		651		15.2		22.4	
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	19.0	B	7.0	U	7.0	U
POTASSIUM	5000	10.0	1160	J	952	J	1420	J	1060	J	1010	J
SELENIUM	5.0	4.0	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	8260	J	8350	J	12700	J	34200	J	13300	J
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	UL
VANADIUM	50.0	3.0	3.0	U	3.0	U	20.9		3.0	U	3.0	U
ZINC	20.0	3.0	30.2	B	21.6	B	56.9	B	9.1	B	13.1	B

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-DG-15		W-MW-DG-16		W-MW-DG-22		W-MW-DG-24		W-MW-DG-28	
LABORATORY ID:			940275-06		940275-07		940275-08		940275-09		940275-10	
ANALYTE	CRQL	MDL										
CHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
VINYL CHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
METHYLENE CHLORIDE	2.0	2.0	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U
ACETONE	5.0	5.0	5.0	UR	52. ~~5.0~~	UR L	5.0	UR	5.0	UR	5.0	UR
CARBON DISULFIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
2-BUTANONE	5.0	5.0	5.0	UR	5.0	UR	5.0	UR	5.0	UR	5.0	UR
1,1,1-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CARBON TETRACHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMODICHLORMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DIBROMOCHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1,2-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
4-METHYL-2-PENTANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
2-HEXANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
TETRACHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1,2,2-TETRACHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TOLUENE	1.0	1.0	1.0	U	1.0	U	2.0		1.0		1.0	U
CHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
ETHYLBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
STYRENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
XYLENE(TOTAL)	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMOETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,3-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,4-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMO-3-CHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

* Result taken from dilution analysis

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-BG-2		W-MW-BG-6		W-MW-DG-4		W-MW-DG-5		W-MW-DG-6	
LABORATORY ID:			940275-01		940275-02		940275-03		940275-04		940275-05	
ANALYTE	CRQL	MDL										
CHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
VINYL CHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
METHYLENE CHLORIDE	2.0	2.0	2.0	U	2.0	U	2.0	B	2.0	U	2.0	U
ACETONE	5.0	5.0	5.0	UR	5.0	UR	5.0	UR	5.0	UR	17.0	L
CARBON DISULFIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
2-BUTANONE	5.0	5.0	5.0	UR	5.0	UR	5.0	UR	5.0	UR	5.0	UR
1,1,1-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CARBON TETRACHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMODICHLORMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DIBROMOCHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1,2-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
4-METHYL-2-PENTANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
2-HEXANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
TETRACHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1,2,2-TETRACHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TOLUENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
ETHYLBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
STYRENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
XYLENE(TOTAL)	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMOETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,3-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,4-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMO-3-CHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

* Result taken from dilution analysis

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-MW-HN-24X		W-MW-HN-25I		W-MW-HN-25S		W-MW-HN-26I		W-MW-HN-26S	
LABORATORY ID:			940275-16		940275-17		940275-18		940275-19		940275-20	
ANALYTE	CRQL	MDL										
CHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
VINYL CHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
METHYLENE CHLORIDE	2.0	2.0	2.0	B	1.0	B	2.0	B	2.0	B	1.0	B
ACETONE	5.0	5.0	15.0	L	5.0	UR	5.0	UR	14.0	L	8.0	L
CARBON DISULFIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
2-BUTANONE	5.0	5.0	5.0	UR	5.0	UR	5.0	UR	5.0	UR	5.0	UR
1,1,1-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CARBON TETRACHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMODICHLORMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DIBROMOCHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1,2-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
4-METHYL-2-PENTANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
2-HEXANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
TETRACHLOROETHENE	1.0	1.0	16.0		2.0		1.0	U	1.0	U	1.0	U
1,1,2,2-TETRACHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TOLUENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
ETHYLBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
STYRENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
XYLENE(TOTAL)	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMOETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,3-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,4-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMO-3-CHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-23I		W-MW-HN-23S		W-MW-HN-24I		W-MW-HN-24S		W-MW-HN-24S	
LABORATORY ID:			940275-11		940275-12		940275-13		940275-14		940275-15	
ANALYTE	CRQL	MDL										
CHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
VINYL CHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
METHYLENE CHLORIDE	2.0	2.0	2.0	B	2.0	U	2.0	B	2.0	B	1.0	B
ACETONE	5.0	5.0	5.0	UR	74.0	L	10.0	L	5.0	UR	34.0	L
CARBON DISULFIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
2-BUTANONE	5.0	5.0	5.0	UR	5.0	UR	5.0	UR	5.0	UR	5.0	UR
1,1,1-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CARBON TETRACHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMODICHLORMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DIBROMOCHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1,2-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
4-METHYL-2-PENTANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
2-HEXANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
TETRACHLOROETHENE	1.0	1.0	1.0	U	3.0		2.0		16.0		29.0	*
1,1,2,2-TETRACHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TOLUENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
ETHYLBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
STYRENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
XYLENE(TOTAL)	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMOETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,3-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,4-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMO-3-CHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

* Result taken from dilution analysis

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			GW-RB-11		W-TB-11	
LABORATORY ID:			940275-26		940275-27	
ANALYTE	CRQL	MDL				
CHLOROMETHANE	1.0	1.0	1.0	U	1.0	U
BROMOMETHANE	1.0	1.0	1.0	U	1.0	U
VINYL CHLORIDE	1.0	1.0	1.0	U	1.0	U
CHLOROETHANE	1.0	1.0	1.0	U	1.0	U
METHYLENE CHLORIDE	2.0	2.0	2.0	U	1.0	B
ACETONE	5.0	5.0	5.0	UR	5.0	UR
CARBON DISULFIDE	1.0	1.0	1.0	U	1.0	U
1,1-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U
1,1-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U
CIS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U
TRANS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U
CHLOROFORM	1.0	1.0	1.0	U	1.0	U
1,2-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U
2-BUTANONE	5.0	5.0	5.0	UR	5.0	UR
1,1,1-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U
CARBON TETRACHLORIDE	1.0	1.0	1.0	U	1.0	U
BROMODICHLORMETHANE	1.0	1.0	1.0	U	1.0	U
1,2-DICHLOROPROPANE	1.0	1.0	1.0	U	1.0	U
CIS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U
TRICHLOROETHENE	1.0	1.0	1.0	U	1.0	U
DIBROMOCHLOROMETHANE	1.0	1.0	1.0	U	1.0	U
1,1,2-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U
BENZENE	1.0	1.0	1.0	U	1.0	U
TRANS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U
BROMOFORM	1.0	1.0	1.0	U	1.0	U
4-METHYL-2-PENTANONE	5.0	5.0	5.0	U	5.0	U
2-HEXANONE	5.0	5.0	5.0	U	5.0	U
TETRACHLOROETHENE	1.0	1.0	1.0	U	1.0	U
1,1,2,2-TETRACHLOROETHANE	1.0	1.0	1.0	U	1.0	U
TOLUENE	1.0	1.0	1.0	U	1.0	U
CHLOROBENZENE	1.0	1.0	1.0	U	1.0	U
ETHYLBENZENE	1.0	1.0	1.0	U	1.0	U
STYRENE	1.0	1.0	1.0	U	1.0	U
XYLENE(TOTAL)	1.0	1.0	1.0		1.0	U
1,2-DIBROMOETHANE	1.0	1.0	1.0	U	1.0	U
1,3-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U
1,4-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U
1,2-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U
1,2-DIBROMO-3-CHLOROPROPANE	1.0	1.0	1.0	U	1.0	U
DILUTION FACTOR:			1.0		1.0	

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CEIMIC CORPORATION

CLIENT ID:			W-MW-HN-28X		W-MW-HN-29I		W-MW-HN-29S		W-MW-HN-29X		W-MW-HN-34X	
LABORATORY ID:			940275-21		940275-22		940275-23		940275-24		940275-25	
ANALYTE	CRQL	MDL										
CHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
VINYL CHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
METHYLENE CHLORIDE	2.0	2.0	1.0	B	2.0	U	2.0	B	2.0	U	2.0	U
ACETONE	5.0	5.0	10.0	L	5.0	UR	10.0	L	15.0	L	5.0	UR
CARBON DISULFIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
2-BUTANONE	5.0	5.0	5.0	UR	5.0	UR	5.0	UR	5.0	UR	5.0	UR
1,1,1-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CARBON TETRACHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMODICHLORMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DIBROMOCHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1,2-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
4-METHYL-2-PENTANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
2-HEXANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
TETRACHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	2.0	
1,1,2,2-TETRACHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TOLUENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
ETHYLBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
STYRENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
XYLENE(TOTAL)	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMOETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,3-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,4-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMO-3-CHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

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CEIMIC CORPORATION

CLIENT ID:			W-MW-HN26S		W-MW-HN27I		W-MW-HN27S		W-MW-HN34S		W-MW-MW1	
LABORATORY ID:			940285-06		940285-07		940285-08		940285-09		940285-10	
ANALYTE	CRQL	MDL										
CHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
VINYL CHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
METHYLENE CHLORIDE	2.0	2.0	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U
ACETONE	5.0	5.0	5.0	UR	5.0	UR	5.0	B	5.0	UR	5.0	UR
CARBON DISULFIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
2-BUTANONE	5.0	5.0	5.0	UR	5.0	UR	5.0	UR	5.0	UR	5.0	UR
1,1,1-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CARBON TETRACHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMODICHLORMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DIBROMOCHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1,2-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
4-METHYL-2-PENTANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
2-HEXANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
TETRACHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	9.0		1.0	
1,1,2,2-TETRACHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TOLUENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
ETHYLBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
STYRENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
XYLENE(TOTAL)	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMOETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,3-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,4-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMO-3-CHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-FBC1		W-FBC2		W-MW-BG5		W-MW-DG14		W-MW-HN26I	
LABORATORY ID:			940285-01		940285-02		940285-03		940285-04		940285-05	
ANALYTE	CRQL	MDL										
CHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
VINYL CHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
METHYLENE CHLORIDE	2.0	2.0	2.0	U	2.0	U	2.0	U	2.0	U	2.0	U
ACETONE	5.0	5.0	5.0	UR	10.0	L	5.0	UR	7.0	B	5.0	UR
CARBON DISULFIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CHLOROFORM	1.0	1.0	3.0		1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
2-BUTANONE	5.0	5.0	5.0	UR	5.0	UR	5.0	UR	5.0	UR	5.0	UR
1,1,1-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CARBON TETRACHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMODICHLORMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CIS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DIBROMOCHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,1,2-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TRANS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
BROMOFORM	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
4-METHYL-2-PENTANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
2-HEXANONE	5.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
TETRACHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0		1.0	U	1.0	U
1,1,2,2-TETRACHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
TOLUENE	1.0	1.0	1.0	U	3.0		1.0	U	1.0	U	1.0	U
CHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
ETHYLBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
STYRENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
XYLENE(TOTAL)	1.0	1.0	1.0	U	2.0		1.0	U	1.0	U	1.0	U
1,2-DIBROMOETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,3-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,4-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
1,2-DIBROMO-3-CHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

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CEIMIC CORPORATION

CLIENT ID:			W-MW-MW2		W-RB12		W-TB-12	
LABORATORY ID:			940285-11		940285-12		940285-13	
ANALYTE	CRQL	MDL						
CHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U
BROMOMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U
VINYL CHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U
CHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U
METHYLENE CHLORIDE	2.0	2.0	2.0	U	2.0	U	2.0	U
ACETONE	5.0	5.0	5.0	UR	5.0	UR	5.0	UR
CARBON DISULFIDE	1.0	1.0	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U
1,1-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U
CIS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U
TRANS-1,2-DICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U
CHLOROFORM	1.0	1.0	1.0	U	1.0	U	1.0	U
1,2-DICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U
2-BUTANONE	5.0	5.0	5.0	UR	5.0	UR	5.0	UR
1,1,1-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U
CARBON TETRACHLORIDE	1.0	1.0	1.0	U	1.0	U	1.0	U
BROMODICHLORMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U
1,2-DICHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U
CIS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U
TRICHLOROETHENE	1.0	1.0	1.0	U	1.0	U	1.0	U
DIBROMOCHLOROMETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U
1,1,2-TRICHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U
BENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U
TRANS-1,3-DICHLOROPROPENE	1.0	1.0	1.0	U	1.0	U	1.0	U
BROMOFORM	1.0	1.0	1.0	U	1.0	U	1.0	U
4-METHYL-2-PENTANONE	5.0	5.0	5.0	U	5.0	U	5.0	U
2-HEXANONE	5.0	5.0	5.0	U	5.0	U	5.0	U
TETRACHLOROETHENE	1.0	1.0	2.0		1.0	U	1.0	U
1,1,2,2-TETRACHLOROETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U
TOLUENE	1.0	1.0	1.0	U	2.0		1.0	U
CHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U
ETHYLBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U
STYRENE	1.0	1.0	1.0	U	1.0	U	1.0	U
XYLENE(TOTAL)	1.0	1.0	1.0	U	1.0		1.0	U
1,2-DIBROMOETHANE	1.0	1.0	1.0	U	1.0	U	1.0	U
1,3-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U
1,4-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U
1,2-DICHLOROBENZENE	1.0	1.0	1.0	U	1.0	U	1.0	U
1,2-DIBROMO-3-CHLOROPROPANE	1.0	1.0	1.0	U	1.0	U	1.0	U
DILUTION FACTOR:			1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-28		XW-MW-HN-29		W-MW-HN-29		SW-MW-HN-29		XW-MW-HN-34X	
LABORATORY ID:			940275-21		940275-22		940275-23		940275-24		940275-25	
ANALYTE	CRQL	MDL										
2,4-DINITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
DIBENZOFURAN	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	U
DIETHYL PHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	U
FLUORENE	10	1	10	U	10	U	10	U	10	U	10	U
4-NITROANILINE	25	2.5	25	UJ	25	UJ	25	UJ	25	UJ	25	UJ
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U	10	U	10	U	10	U	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
PENTACHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
PHENANTHRENE	10	1	10	U	10	U	10	U	10	U	10	U
ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
DI-n-BUTYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
CARBAZOLE	10	1	10	U	10	U	10	U	10	U	10	U
PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
BUTYLBENZYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(a)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
CHRYSENE	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	2	B	1	B	3	B	3	B	18	B
DI-n-OCTYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(b)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(k)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(a)PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
INDENO(1,2,3-cd)PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
DIBENZO(a,h)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(g,h,i)PERYLENE	10	1	10	U	10	U	10	U	10	U	10	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-28		XW-MW-HN-29		W-MW-HN-29		SW-MW-HN-29		XW-MW-HN-34X	
LABORATORY ID:			940275-21		940275-22		940275-23		940275-24		940275-25	
ANALYTE	CRQL	MDL										
PHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U	10	U	10	U	10	U	10	U
2-CHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
1,4-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
1,2-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U	10	U	10	U	10	U	10	U
4-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROETHANE	10	1	10	U	10	U	10	U	10	U	10	U
NITROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
ISOPHORONE	10	1	10	U	10	U	10	U	10	U	10	U
2-NITROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
NAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
4-CHLOROANILINE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROBUTADIENE	10	1	10	U	10	U	10	U	10	U	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	U	10	U	10	U	10	U	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
2-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	U
DIMETHYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
ACENAPHTHYLENE	10	1	10	U	10	U	10	U	10	U	10	U
2,6-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	U
3-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	U
ACENAPHTHENE	10	1	10	U	10	U	10	U	10	U	10	U

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-RB-11	
LABORATORY ID:			940275-26	
ANALYTE	CRQL	MDL		
2,4-DINITROPHENOL	25	2.5	25	U
4-NITROPHENOL	25	2.5	25	U
DIBENZOFURAN	10	1	10	U
2,4-DINITROTOLUENE	10	1	10	U
DIETHYL PHTHALATE	10	1	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U
FLUORENE	10	1	10	U
4-NITROANILINE	25	2.5	25	U
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U
HEXACHLOROBENZENE	10	1	10	U
PENTACHLOROPHENOL	25	2.5	25	U
PHENANTHRENE	10	1	10	U
ANTHRACENE	10	1	10	U
DI-n-BUTYLPHTHALATE	10	1	10	U
FLUORANTHENE	10	1	10	U
CARBAZOLE	10	1	10	UJ
PYRENE	10	1	10	U
BUTYLBENZYLPHTHALATE	10	1	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	UJ
BENZO(a)ANTHRACENE	10	1	10	U
CHRYSENE	10	1	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	5	J
DI-n-OCTYLPHTHALATE	10	1	10	U
BENZO(b)FLUORANTHENE	10	1	10	U
BENZO(k)FLUORANTHENE	10	1	10	U
BENZO(a)PYRENE	10	1	10	U
INDENO(1,2,3-cd)PYRENE	10	1	10	U
DIBENZO(a,h)ANTHRACENE	10	1	10	U
BENZO(g,h,i)PERYLENE	10	1	10	U
DILUTION FACTOR:			1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID: W-RB-11
LABORATORY ID: 940275-26

ANALYTE	CRQL	MDL		
PHENOL	10	1	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U
2-CHLOROPHENOL	10	1	10	U
1,3-DICHLOROBENZENE	10	1	10	U
1,4-DICHLOROBENZENE	10	1	10	U
1,2-DICHLOROBENZENE	10	1	10	U
2-METHYLPHENOL	10	1	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U
4-METHYLPHENOL	10	1	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U
HEXACHLOROETHANE	10	1	10	U
NITROBENZENE	10	1	10	U
ISOPHORONE	10	1	10	U
2-NITROPHENOL	10	1	10	U
2,4-DIMETHYLPHENOL	10	1	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U
2,4-DICHLOROPHENOL	10	1	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U
NAPHTHALENE	10	1	10	U
4-CHLOROANILINE	10	1	10	U
HEXACHLOROBUTADIENE	10	1	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U
2-METHYLNAPHTHALENE	10	1	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U
2-CHLORONAPHTHALENE	10	1	10	U
2-NITROANILINE	25	2.5	25	U
DIMETHYLPHTHALATE	10	1	10	U
ACENAPHTHYLENE	10	1	10	U
2,6-DINITROTOLUENE	10	1	10	U
3-NITROANILINE	25	2.5	25	U
ACENAPHTHENE	10	1	10	U

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-28I		W-MW-HN-28S	
LABORATORY ID:			940275-19		940275-20	
ANALYTE	CRQL	MDL				
2,4-DINITROPHENOL	25	2.5	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U
DIBENZOFURAN	10	1	10	U	10	U
2,4-DINITROTOLUENE	10	1	10	U	10	U
DIETHYL PHTHALATE	10	1	10	U	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U	10	U
FLUORENE	10	1	10	U	10	U
4-NITROANILINE	25	2.5	25	UJ	25	UJ
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U	10	U
HEXACHLOROBENZENE	10	1	10	U	10	U
PENTACHLOROPHENOL	25	2.5	25	U	25	U
PHENANTHRENE	10	1	10	U	10	U
ANTHRACENE	10	1	10	U	10	U
DI-n-BUTYLPHTHALATE	10	1	10	U	1	J
FLUORANTHENE	10	1	10	U	10	U
CARBAZOLE	10	1	10	U	10	U
PYRENE	10	1	10	U	10	U
BUTYLBENZYLPHTHALATE	10	1	10	U	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	U	10	U
BENZO(a)ANTHRACENE	10	1	10	U	10	U
CHRYSENE	10	1	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	10	U	10	U
DI-n-OCTYLPHTHALATE	10	1	10	U	10	U
BENZO(b)FLUORANTHENE	10	1	10	U	10	U
BENZO(k)FLUORANTHENE	10	1	10	U	10	U
BENZO(a)PYRENE	10	1	10	U	10	U
INDENO(1,2,3-cd)PYRENE	10	1	10	U	10	U
DIBENZO(a,h)ANTHRACENE	10	1	10	U	10	U
BENZO(g,h,i)PERYLENE	10	1	10	U	10	U
DILUTION FACTOR:			1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-28I		W-MW-HN-28S	
LABORATORY ID:			940275-19		940275-20	
ANALYTE	CRQL	MDL				
PHENOL	10	1	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U	10	U
2-CHLOROPHENOL	10	1	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	U	10	U
1,4-DICHLOROBENZENE	10	1	10	U	10	U
1,2-DICHLOROBENZENE	10	1	10	U	10	U
2-METHYLPHENOL	10	1	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U	10	U
4-METHYLPHENOL	10	1	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U	10	U
HEXACHLOROETHANE	10	1	10	U	10	U
NITROBENZENE	10	1	10	U	10	U
ISOPHORONE	10	1	10	U	10	U
2-NITROPHENOL	10	1	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U	10	U
2,4-DICHLOROPHENOL	10	1	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U	10	U
NAPHTHALENE	10	1	10	U	10	U
4-CHLOROANILINE	10	1	10	U	10	U
HEXACHLOROBUTADIENE	10	1	10	U	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	U	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	U	10	U
2-NITROANILINE	25	2.5	25	U	25	U
DIMETHYLPHTHALATE	10	1	10	U	10	U
ACENAPHTHYLENE	10	1	10	U	10	U
2,6-DINITROTOLUENE	10	1	10	U	10	U
3-NITROANILINE	25	2.5	25	U	25	U
ACENAPHTHENE	10	1	10	U	10	U

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TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-DG-16		W-MW-DG-28		W-MW-HN-23I		W-MW-HN-23S		W-MW-HN-23X	
LABORATORY ID:			940275-07		940275-10		940275-11		940275-12		940275-13	
ANALYTE	CRQL	MDL										
2,4-DINITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
DIBENZOFURAN	10	1	10	UL	10	U	10	U	10	U	10	U
2,4-DINITROTOLUENE	10	1	10	UL	10	U	10	U	10	U	10	U
DIETHYL PHTHALATE	10	1	10	UL	10	U	10	U	10	U	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	UL	10	U	10	U	10	U	10	U
FLUORENE	10	1	10	UL	10	U	10	U	10	U	10	U
4-NITROANILINE	25	2.5	25	UL	25	U	25	U	25	U	25	U
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	UL	10	U	10	U	10	U	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	UL	10	U	10	U	10	U	10	U
HEXACHLOROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
PENTACHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
PHENANTHRENE	10	1	10	UL	10	U	10	U	10	U	10	U
ANTHRACENE	10	1	10	UL	10	U	10	U	10	U	10	U
DI-n-BUTYLPHTHALATE	10	1	10	UL	10	U	10	U	10	U	10	U
FLUORANTHENE	10	1	10	UL	10	U	10	U	10	U	10	U
CARBAZOLE	10	1	10	UL	10	U	10	U	10	U	10	U
PYRENE	10	1	10	UL	10	U	10	U	10	U	10	U
BUTYLBENZYLPHTHALATE	10	1	10	UL	10	U	10	U	10	U	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	UL	10	U	10	U	10	U	10	U
BENZO(a)ANTHRACENE	10	1	10	UL	10	U	10	U	10	U	10	U
CHRYSENE	10	1	10	UL	10	U	10	U	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	1	B	1	B	2	B	2	B	1	B
DI-n-OCTYLPHTHALATE	10	1	10	UL	10	U	10	U	10	U	10	UJ
BENZO(b)FLUORANTHENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
BENZO(k)FLUORANTHENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
BENZO(a)PYRENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
INDENO(1,2,3-cd)PYRENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
DIBENZO(a,h)ANTHRACENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
BENZO(g,h,i)PERYLENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

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CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (µg/L)

CLIENT ID:			W-MW-DG-16		W-MW-DG-28		W-MW-HN-23I		W-MW-HN-23S		W-MW-HN-23X	
LABORATORY ID:			940275-07		940275-10		940275-11		940275-12		940275-13	
ANALYTE	CRQL	MDL										
PHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	UL	10	U	10	U	10	U	10	U
2-CHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
1,4-DICHLOROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
1,2-DICHLOROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
2-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	UL	10	U	10	U	10	U	10	U
4-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	UL	10	U	10	U	10	U	10	U
HEXACHLOROETHANE	10	1	10	UL	10	U	10	U	10	U	10	U
NITROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
ISOPHORONE	10	1	10	UL	10	U	10	U	10	U	10	U
2-NITROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	UL	10	U	10	U	10	U	10	U
2,4-DICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
NAPHTHALENE	10	1	10	UL	10	U	10	U	10	U	10	U
4-CHLOROANILINE	10	1	10	UL	10	U	10	U	10	U	10	U
HEXACHLOROBUTADIENE	10	1	10	UL	10	U	10	U	10	U	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	UL	10	U	10	U	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	UL	10	U	10	U	10	U	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	UL	10	U	10	U	10	U	10	U
2-NITROANILINE	25	2.5	25	UL	25	U	25	U	25	U	25	U
DIMETHYLPHTHALATE	10	1	10	UL	10	U	10	U	10	U	10	U
ACENAPHTHYLENE	10	1	10	UL	10	U	10	U	10	U	10	U
2,6-DINITROTOLUENE	10	1	10	UL	10	U	10	U	10	U	10	U
3-NITROANILINE	25	2.5	25	UL	25	U	25	U	25	U	25	U
ACENAPHTHENE	10	1	10	UL	10	U	10	U	10	U	10	U

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CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-24I		W-MW-HN-24S		W-MW-HN-24X		W-MW-HN-25I		W-MW-HN-25S	
LABORATORY ID:			940275-14		940275-15		940275-16		940275-17		940275-18	
ANALYTE	CRQL	MDL										
2,4-DINITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
DIBENZOFURAN	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	U
DIETHYL PHTHALATE	10	1	10	U	10	U	1	J	10	U	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	U
FLUORENE	10	1	10	U	10	U	10	U	10	U	10	U
4-NITROANILINE	25	2.5	25	UJ	25	UJ	25	UJ	25	U	25	U
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U	10	U	10	U	10	U	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
PENTACHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
PHENANTHRENE	10	1	10	U	10	U	10	U	10	U	10	U
ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
DI-n-BUTYLPHTHALATE	10	1	10	U	10	U	10	U	2	J	2	J
FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
CARBAZOLE	10	1	10	U	10	U	10	UJ	10	UJ	10	U
PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
BUTYLBENZYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	U	10	U	10	U	10	UJ	10	U
BENZO(a)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
CHRYSENE	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	1	B	2	B	1	B	2	B	10	U
DI-n-OCTYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(b)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(k)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(a)PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
INDENO(1,2,3-cd)PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
DIBENZO(a,h)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(g,h,i)PERYLENE	10	1	10	U	10	U	10	U	10	U	10	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-24I		W-MW-HN-24S		W-MW-HN-25I		W-MW-HN-25S		W-MW-HN-26I	
LABORATORY ID:			940275-14		940275-15		940275-16		940275-17		940275-18	
ANALYTE	CRQL	MDL										
PHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U	10	U	10	U	10	U	10	U
2-CHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
1,4-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
1,2-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U	10	U	10	U	10	U	10	U
4-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROETHANE	10	1	10	U	10	U	10	U	10	U	10	U
NITROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
ISOPHORONE	10	1	10	U	10	U	10	U	10	U	10	U
2-NITROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
NAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
4-CHLOROANILINE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROBUTADIENE	10	1	10	U	10	U	10	U	10	U	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	U	10	U	10	U	10	U	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
2-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	U
DIMETHYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
ACENAPHTHYLENE	10	1	10	U	10	U	10	U	10	U	10	U
2,6-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	U
3-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	U
ACENAPHTHENE	10	1	10	U	10	U	10	U	10	U	10	U

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-FBC1		W-FBC2		W-MW-HN26I		W-MW-HN26S		W-MW-HN27I	
LABORATORY ID:			940285-01		940285-02		940285-05		940285-06		940285-07	
ANALYTE	CRQL	MDL										
2,4-DINITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
DIBENZOFURAN	10	1	10	U	10	U	10	U	10	U	10	UL
2,4-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	UL
DIETHYL PHTHALATE	10	1	10	U	10	U	10	U	10	U	10	UL
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	UL
FLUORENE	10	1	10	U	10	U	10	U	10	U	10	UL
4-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	UL
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U	10	U	10	U	10	U	10	UL
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	UL
HEXACHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
PENTACHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
PHENANTHRENE	10	1	10	U	10	U	10	U	10	U	10	UL
ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	UL
DI-n-BUTYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	1	J
FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	UL
CARBAZOLE	10	1	10	UJ	10	UJ	10	UJ	10	UJ	10	UL
PYRENE	10	1	10	U	10	U	10	U	10	U	10	UL
BUTYLBENZYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	UL
3,3'-DICHLOROBENZIDINE	10	1	10	UJ	10	UJ	10	UJ	10	UJ	10	UL
BENZO(a)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	UL
CHRYSENE	10	1	10	U	10	U	10	U	10	U	10	UL
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	10	U	10	U	10	U	1	B	2	B
DI-n-OCTYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	UL
BENZO(b)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	UL
BENZO(k)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	UL
BENZO(a)PYRENE	10	1	10	U	10	U	10	U	10	U	10	UL
INDENO(1,2,3-cd)PYRENE	10	1	10	U	10	U	10	U	10	U	10	UL
DIBENZO(a,h)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	UL
BENZO(g,h,i)PERYLENE	10	1	10	U	10	U	10	U	10	U	10	UL
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-FBC1		W-FBC2		W-MW-HN26I		W-MW-HN26S		W-MW-HN27I	
LABORATORY ID:			940285-01		940285-02		940285-05		940285-06		940285-07	
ANALYTE	CRQL	MDL										
PHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U	10	U	10	U	10	U	10	UL
2-CHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
1,4-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
1,2-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
2-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U	10	U	10	U	10	U	10	UL
4-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U	10	U	10	U	10	U	10	UL
HEXACHLOROETHANE	10	1	10	U	10	U	10	U	10	U	10	UL
NITROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
ISOPHORONE	10	1	10	U	10	U	10	U	10	U	10	UL
2-NITROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U	10	U	10	U	10	U	10	UL
2,4-DICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
NAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	UL
4-CHLOROANILINE	10	1	10	U	10	U	10	U	10	U	10	UL
HEXACHLOROBUTADIENE	10	1	10	U	10	U	10	U	10	U	10	UL
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	UL
HEXACHLOROCYCLOPENTADIENE	10	1	10	U	10	U	10	U	10	U	10	UL
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	UL
2-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	UL
DIMETHYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	UL
ACENAPHTHYLENE	10	1	10	U	10	U	10	U	10	U	10	UL
2,6-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	UL
3-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	UL
ACENAPHTHENE	10	1	10	U	10	U	10	U	10	U	10	UL

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN27S		W-MW-HN34S		W-RB12	
LABORATORY ID:			940285-08		940285-09		940285-12	
ANALYTE	CRQL	MDL						
2,4-DINITROPHENOL	25	2.5	25	U	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U	25	U
DIBENZOFURAN	10	1	10	U	10	U	10	U
2,4-DINITROTOLUENE	10	1	10	U	10	U	10	U
DIETHYL PHTHALATE	10	1	10	U	10	U	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U
FLUORENE	10	1	10	U	10	U	10	U
4-NITROANILINE	25	2.5	25	U	25	U	25	U
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U	10	U	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U
HEXACHLOROBENZENE	10	1	10	U	10	U	10	U
PENTACHLOROPHENOL	25	2.5	25	U	25	U	25	U
PHENANTHRENE	10	1	10	U	10	U	10	U
ANTHRACENE	10	1	10	U	10	U	10	U
DI-n-BUTYLPHTHALATE	10	1	10	U	1	J	10	U
FLUORANTHENE	10	1	10	U	10	U	10	U
CARBAZOLE	10	1	10	UJ	10	UJ	10	UJ
PYRENE	10	1	10	U	10	U	10	U
BUTYLBENZYLPHTHALATE	10	1	10	U	10	U	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	UJ	10	UJ	10	UJ
BENZO(a)ANTHRACENE	10	1	10	U	10	U	10	U
CHRYSENE	10	1	10	U	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	1	B	2	B	10	U
DI-n-OCTYLPHTHALATE	10	1	10	U	10	U	10	U
BENZO(b)FLUORANTHENE	10	1	10	U	10	U	10	U
BENZO(k)FLUORANTHENE	10	1	10	U	10	U	10	U
BENZO(a)PYRENE	10	1	10	U	10	U	10	U
INDENO(1,2,3-cd)PYRENE	10	1	10	U	10	U	10	U
DIBENZO(a,h)ANTHRACENE	10	1	10	U	10	U	10	U
BENZO(g,h,i)PERYLENE	10	1	10	U	10	U	10	U
DILUTION FACTOR:			1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN27S		W-MW-HN34S		W-RB12	
LABORATORY ID:			940285-08		940285-09		940285-12	
ANALYTE	CRQL	MDL						
PHENOL	10	1	10	U	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U	10	U	10	U
2-CHLOROPHENOL	10	1	10	U	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	U	10	U	10	U
1,4-DICHLOROBENZENE	10	1	10	U	10	U	10	U
1,2-DICHLOROBENZENE	10	1	10	U	10	U	10	U
2-METHYLPHENOL	10	1	10	U	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U	10	U	10	U
4-METHYLPHENOL	10	1	10	U	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U	10	U	10	U
HEXACHLOROETHANE	10	1	10	U	10	U	10	U
NITROBENZENE	10	1	10	U	10	U	10	U
ISOPHORONE	10	1	10	U	10	U	10	U
2-NITROPHENOL	10	1	10	U	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U	10	U	10	U
2,4-DICHLOROPHENOL	10	1	10	U	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U	10	U	10	U
NAPHTHALENE	10	1	10	U	10	U	10	U
4-CHLOROANILINE	10	1	10	U	10	U	10	U
HEXACHLOROBUTADIENE	10	1	10	U	10	U	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	U	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	U	10	U	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	U	10	U	10	U
2-NITROANILINE	25	2.5	25	U	25	U	25	U
DIMETHYLPHTHALATE	10	1	10	U	10	U	10	U
ACENAPHTHYLENE	10	1	10	U	10	U	10	U
2,6-DINITROTOLUENE	10	1	10	U	10	U	10	U
3-NITROANILINE	25	2.5	25	U	25	U	25	U
ACENAPHTHENE	10	1	10	U	10	U	10	U

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-MW-HN27S		W-MW-HN34S		W-RB12	
LABORATORY ID:			940285-08		940285-09		940285-12	
ANALYTE	CRQL	MDL						
alpha-BHC	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
beta-BHC	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
delta-BHC	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
gamma-BHC (LINDANE)	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
HEPTACHLOR	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
ALDRIN	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
ENDOSULFAN I	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
DIELDRIN	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
4,4'-DDE	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
ENDRIN	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
ENDOSULFAN II	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
4,4'-DDD	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
ENDOSULFAN SULFATE	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
4,4'-DDT	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
METHOXYCHLOR	0.50	0.10	0.50	UL	0.50	UL	0.50	UL
ENDRIN KETONE	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
ENDRIN ALDEHYDE	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
alpha-CHLORDANE	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
gamma-CHLORDANE	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
TOXAPHENE	5.0	1.67	5.0	UL	5.0	UL	5.0	UL
AROCLOR-1016	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1221	2.0	0.67	2.0	UL	2.0	UL	2.0	UL
AROCLOR-1232	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1242	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1248	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1254	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1260	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
DILUTION FACTOR:			1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-FBC1		W-FBC2		W-MW-HN26I		W-MW-HN26S		W-MW-HN27I	
LABORATORY ID:			940285-01		940285-02		940285-05		940285-06		940285-07	
ANALYTE	CRQL	MDL										
alpha-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
beta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
delta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
gamma-BHC (LINDANE)	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
HEPTACHLOR	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
ALDRIN	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
ENDOSULFAN I	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
DIELDRIN	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
4,4'-DDE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
ENDRIN	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
ENDOSULFAN II	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
4,4'-DDD	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
ENDOSULFAN SULFATE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
4,4'-DDT	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
METHOXYCHLOR	0.50	0.10	0.50	U	0.50	U	0.50	UL	0.50	UL	0.50	UL
ENDRIN KETONE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
ENDRIN ALDEHYDE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
alpha-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
gamma-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
TOXAPHENE	5.0	1.67	5.0	U	5.0	U	5.0	UL	5.0	UL	5.0	UL
AROCLOR-1016	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1221	2.0	0.67	2.0	U	2.0	U	2.0	UL	2.0	UL	2.0	UL
AROCLOR-1232	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1242	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1248	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1254	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1260	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS PESTICIDES/PCB's (ug/L)

CLIENT ID:			W-MW-HN-24I		W-MW-HN-24S		W-MW-HN-24X		W-MW-HN-28I		W-MW-HN-28S	
LABORATORY ID:			940275-14		940275-15		940275-16		940275-19		940275-20	
ANALYTE	CRQL	MDL										
alpha-BHC	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
beta-BHC	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
delta-BHC	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
gamma-BHC (LINDANE)	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
HEPTACHLOR	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
ALDRIN	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
ENDOSULFAN I	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
DIELDRIN	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
4,4'-DDE	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
ENDRIN	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
ENDOSULFAN II	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.24	J
4,4'-DDD	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
ENDOSULFAN SULFATE	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
4,4'-DDT	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
METHOXYCHLOR	0.50	0.10	0.50	U	0.50	UL	0.50	UL	0.50	U	0.50	UL
ENDRIN KETONE	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
ENDRIN ALDEHYDE	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
alpha-CHLORDANE	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
gamma-CHLORDANE	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
TOXAPHENE	5.0	1.67	5.0	U	5.0	UL	5.0	UL	5.0	U	5.0	UL
AROCLOR-1016	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
AROCHLOR-1221	2.0	0.67	2.0	U	2.0	UL	2.0	UL	2.0	U	2.0	UL
AROCLOR-1232	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
AROCLOR-1242	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
AROCLOR-1248	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
AROCLOR-1254	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
AROCLOR-1260	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS PESTICIDES/PCB's (ug/L)

CLIENT ID:			W-MW-DG-16		W-MW-DG-28		W-MW-HN-23I		W-MW-HN-23S		W-MW-HN-23X	
LABORATORY ID:			940275-07		940275-10		940275-11		940275-12		940275-13	
ANALYTE	CRQL	MDL										
alpha-BHC	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
beta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
delta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
gamma-BHC (LINDANE)	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
HEPTACHLOR	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
ALDRIN	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
ENDOSULFAN I	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
DIELDRIN	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
4,4'-DDE	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
ENDRIN	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
ENDOSULFAN II	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
4,4'-DDD	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
ENDOSULFAN SULFATE	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
4,4'-DDT	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
METHOXYCHLOR	0.50	0.10	0.50	U	0.50	U	0.50	U	0.50	UL	0.50	UL
ENDRIN KETONE	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
ENDRIN ALDEHYDE	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
alpha-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
gamma-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
TOXAPHENE	5.0	1.67	5.0	U	5.0	U	5.0	U	5.0	UL	5.0	UL
AROCLOR-1016	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
AROCHLOR-1221	2.0	0.67	2.0	U	2.0	U	2.0	U	2.0	UL	2.0	UL
AROCLOR-1232	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
AROCLOR-1242	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
AROCLOR-1248	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
AROCLOR-1254	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
AROCLOR-1260	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-RB-11	
LABORATORY ID:			940275-26	
ANALYTE	CRQL	MDL		
alpha-BHC	0.050	0.010	0.050	UL
beta-BHC	0.050	0.010	0.050	UL
delta-BHC	0.050	0.010	0.050	UL
gamma-BHC (LINDANE)	0.050	0.010	0.050	UL
HEPTACHLOR	0.050	0.010	0.050	UL
ALDRIN	0.050	0.010	0.050	UL
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	UL
ENDOSULFAN I	0.050	0.010	0.050	UL
DIELDRIN	0.10	0.020	0.10	UL
4,4'-DDE	0.10	0.020	0.10	UL
ENDRIN	0.10	0.020	0.10	UL
ENDOSULFAN II	0.10	0.020	0.10	UL
4,4'-DDD	0.10	0.020	0.10	UL
ENDOSULFAN SULFATE	0.10	0.020	0.10	UL
4,4'-DDT	0.10	0.020	0.10	UL
METHOXYCHLOR	0.50	0.10	0.50	UL
ENDRIN KETONE	0.10	0.020	0.10	UL
ENDRIN ALDEHYDE	0.10	0.020	0.10	UL
alpha-CHLORDANE	0.050	0.010	0.050	UL
gamma-CHLORDANE	0.050	0.010	0.050	UL
TOXAPHENE	5.0	1.67	5.0	UL
AROCLOR-1016	1.0	0.33	1.0	UL
AROCLOR-1221	2.0	0.67	2.0	UL
AROCLOR-1232	1.0	0.33	1.0	UL
AROCLOR-1242	1.0	0.33	1.0	UL
AROCLOR-1248	1.0	0.33	1.0	UL
AROCLOR-1254	1.0	0.33	1.0	UL
AROCLOR-1260	1.0	0.33	1.0	UL
DILUTION FACTOR:			1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-MW-HN-28		XW-MW-HN-29		W-MW-HN-29		SW-MW-HN-29		XW-MW-HN-34X	
LABORATORY ID:			940275-21		940275-22		940275-23		940275-24		940275-25	
ANALYTE	CRQL	MDL										
alpha-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
beta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
delta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
gamma-BHC (LINDANE)	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
HEPTACHLOR	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
ALDRIN	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
ENDOSULFAN I	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
DIELDRIN	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
4,4'-DDE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
ENDRIN	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
ENDOSULFAN II	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
4,4'-DDD	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
ENDOSULFAN SULFATE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
4,4'-DDT	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
METHOXYCHLOR	0.50	0.10	0.50	U	0.50	U	0.50	UL	0.50	UL	0.50	U
ENDRIN KETONE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
ENDRIN ALDEHYDE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
alpha-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
gamma-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
TOXAPHENE	5.0	1.67	5.0	U	5.0	U	5.0	UL	5.0	UL	5.0	U
AROCLOR-1016	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
AROCLOR-1221	2.0	0.67	2.0	U	2.0	U	2.0	UL	2.0	UL	2.0	U
AROCLOR-1232	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
AROCLOR-1242	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
AROCLOR-1248	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
AROCLOR-1254	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
AROCLOR-1260	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
DILUTION FACTOR:		1	1.0		1.0		1.0		1.0		1.0	

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TAL AQUEOUS TOTAL METALS (ug/L)

CLIENT ID:			W-MW-HN-28X		W-MW-HN-29I		W-MW-HN-29S		W-MW-HN-29X		W-MW-HN-34X	
LABORATORY ID:			942275-21		942275-22		942275-23		942275-24		942275-25	
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	45.9		33.0	U	225		20900		99.5	
ANTIMONY	60.0	34.0	47.3	L	34.0	UL	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.0	U	3.5	K	3.0	K	6.6	K	5.4	K
BARIUM	200	7.0	380		342		216		253		265	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.1		1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	33800		33500		54500		43500		27800	
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	15.5		7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	4.0	U	18.6	B	4.1	B
COPPER	25.0	6.0	6.0	U	6.0	U	7.7	K	79.2		7.6	K
IRON	100	5.0	293		276		206	B	15400		120	B
LEAD	3.0	1.0	1.0	U	1.0	U	1.0	U	6.1	B	2.1	B
MAGNESIUM	5000	27.0	13600		13500		15200		33700		7570	
MANGANESE	15.0	1.0	578		575		67.6		1840		13.5	
MERCURY	0.20	0.10	0.13	U	0.13	U	0.14	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	25.7	B	7.0	U
POTASSIUM	5000	10.0	836		796		2000		2040		865	
SELENIUM	5.0	4.0	4.0	UL	4.0	UL	4.0	UL	4.0	UL	4.0	UL
SILVER	10.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
SODIUM	5000	51.0	10600		10400		22400		17400		8550	
THALLIUM	10.0	4.0	4.0	U	5.1		4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	21.7		3.0	U
ZINC	20.0	3.0	3.0	U	3.0	U	71.3		47.8		46.2	

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-MW-BG-2		W-MW-BG-6		W-MW-DG-15		W-MW-DG-16		W-MW-DG-22	
LABORATORY ID			940275-01		940275-02		940275-06		940275-07		940275-08	

TAL AQUEOUS TOTAL METALS (ug/L)

ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	7370		169		383		79.2	
ANTIMONY	60.0	34.0	34.0	UL	34.0	UL	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.0	U	5.9		3.1		4.4		3.0	U
BARIUM	200	7.0	40.8	J	114	J	329	J	442	J	381	J
BERYLLIUM	5.0	1.0	1.0	U	1.5		1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.8	K	3.0	U	3.0	U	3.2	K
CALCIUM	5000	7.0	11900	J	15200	J	67700	J	51700	J	50700	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.1		4.0	UL	4.0	UL	4.0	UL
COPPER	25.0	6.0	7.8		10.1		6.0	U	6.0	U	6.0	U
IRON	100	5.0	5650	J	3130	J	172	B	590	J	125	B
LEAD	3.0	1.0	1.0	U	11.9		1.0	U	1.0	U	1.0	U
MAGNESIUM	5000	27.0	5130	J	5450	J	10900	J	16800	J	12200	J
MANGANESE	15.0	1.0	451		89.9		1720		20.2		106	
MERCURY	0.20	0.10	0.13	U	0.17		0.14	U	0.13	U	0.13	U
NICKEL	40.0	7.0	10.3	B	7.0	U	7.0	U	9.1	B	7.0	U
POTASSIUM	5000	10.0	2360	J	1350	J	1220	J	1760	J	1590	J
SELENIUM	5.0	4.0	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	5370	J	12700	J	12100	J	10500	J	10300	J
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	UL	4.0	UL	4.0	UL
VANADIUM	50.0	3.0	3.0	U	4.5	B	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	10.3	B	38.4	B	21.2	B	10.8	B	17.4	B

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID LABORATORY ID			W-MW-HN-24X 940275-16		W-MW-HN-25I 940275-17		W-MW-HN-25S 940275-18		W-MW-HN-28I 940275-19		W-MW-HN-28S 940275-20	
TAL AQUEOUS TOTAL METALS (ug/L)												
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	393		677		6920		60.2		2340	
ANTIMONY	60.0	34.0	34.0	UL	34.0	UL	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	7.1		3.0	U	5.0		3.9		13.6	
BARIUM	200	7.0	243	J	234	J	554	J	351	J	198	J
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.5		1.0	U	1.0	U
CADMIUM	5.0	3.0	3.4	K	4.3	K	4.4	K	3.0	U	3.0	U
CALCIUM	5000	7.0	36400	J	38700	J	35900	J	35600	J	23200	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	14.0	K	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
COPPER	25.0	6.0	7.1		19.8		13.1		6.0	U	6.0	U
IRON	100	5.0	513	J	1090	J	3150	J	576	J	1440	J
LEAD	3.0	1.0	1.0		6.7		10.9		1.0	U	3.1	
MAGNESIUM	5000	27.0	12400	J	9980	J	6820	J	12900	J	10200	J
MANGANESE	15.0	1.0	26.6		235		354		719		46.0	
MERCURY	0.20	0.10	0.13	U	0.20		0.22		0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	10.4	B	8.6	B	7.0	U	7.0	U
POTASSIUM	5000	10.0	1120	J	1350	J	1380	J	1070	J	1940	J
SELENIUM	5.0	4.0	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	35200	J	11700	J	25900	J	9810	J	24000	J
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.3	B	3.0	U	4.5	B	3.0	U	4.8	B
ZINC	20.0	3.0	27.6	B	39.1	B	58.5	B	23.6	B	24.5	B

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-FBC1		W-FBC2		W-MW-BG5		W-MW-DG14		W-MW-HN26I	
LABORATORY ID:			940285-01		940285-02		940285-03		940285-04		940285-05	
TAL AQUEOUS TOTAL METALS (ug/L)												
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	79.8		366		121		33.0	U	131	
ANTIMONY	60.0	34.0	41.0	B	38.9	B	34.0	UJ	34.0	UJ	34.0	UJ
ARSENIC	10.0	3.0	3.1	B	3.0	U	3.0	U	3.0	U	3.0	U
BARIUM	200	7.0	28.3		7.0	U	154		101		175	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	18100		576		15000		17200		21200	
CHROMIUM	10.0	7.0	11.0	B	12.3	B	12.0	B	12.6	B	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.2	B
COPPER	25.0	6.0	395		6.0	U	8.5		7.3		6.0	U
IRON	100	5.0	42.4	B	333		107		45.7	B	79.4	B
LEAD	3.0	1.0	1.7	L	1.0	UL	1.0	UL	1.0	UL	1.0	UL
MAGNESIUM	5000	27.0	6220		1350		4710		4980		12700	
MANGANESE	15.0	1.0	23.9		2.0	B	66.2		2.6	B	6.2	B
MERCURY	0.20	0.10	0.13	U	0.24		0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	1780		417	B	924		761	B	1130	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	11200		148	B	6530		8560		11500	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	60.0		3.0		9.8		25.0		16.2	

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-MW-HN26S		W-MW-HN27I		W-MW-HN27S		W-MW-HN34S		W-MW-MW1	
LABORATORY ID			940285-06		940285-07		940285-08		940285-09		940285-10	

TAL AQUEOUS TOTAL METALS (ug/L)

ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	2100		189		83.9		200		668	
ANTIMONY	60.0	34.0	57.5	B	34.0	UJ	50.0	B	34.0	UJ	34.0	UJ
ARSENIC	10.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
BARIUM	200	7.0	223		376		154		179		211	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	18500		31800		16600		39900		20100	
CHROMIUM	10.0	7.0	7.5	B	7.0	U	13.2	B	7.0	U	10.6	B
COBALT	50.0	4.0	4.0	U	4.0	U	5.0	B	5.0	B	6.1	B
COPPER	25.0	6.0	10.4		6.0	U	7.7		25.8		6.6	
IRON	100	5.0	1770		238		68.8	B	337		1040	
LEAD	3.0	1.0	1.7	L	1.0	UL	1.0	UL	2.7	L	1.0	UL
MAGNESIUM	5000	27.0	6980		13300		7270		14100		5240	
MANGANESE	15.0	1.0	266		85.2		14.7		26.1		140	
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	1150		1620		1680		1200		915	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	8330		10700		12100		10600		7650	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.1		3.0	U	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	14.1		29.2		11.4		48.8		8.4	

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CEIMIC CORPORATION

CLIENT ID:			W-MW-MW2		W-RB12	
LABORATORY ID.			940285-11		940285-12	

TAL AQUEOUS TOTAL METALS (ug/L)

ANALYTE	CRDL	IDL				
ALUMINUM	200	33.0	461		33.0	U
ANTIMONY	60.0	34.0	34.0	UJ	64.1	J
ARSENIC	10.0	3.0	3.0	U	3.0	U
BARIUM	200	7.0	213		7.0	U
BERYLLIUM	5.0	1.0	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U
CALCIUM	5000	7.0	19900		80.8	B
CHROMIUM	10.0	7.0	14.7	B	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U
COPPER	25.0	6.0	6.8		6.0	U
IRON	100	5.0	864		12.0	B
LEAD	3.0	1.0	1.0	UL	1.0	UL
MAGNESIUM	5000	27.0	5040		27.0	U
MANGANESE	15.0	1.0	131		1.1	B
MERCURY	0.20	0.10	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U
POTASSIUM	5000	10.0	797	B	109	B
SELENIUM	5.0	4.0	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL
SODIUM	5000	51.0	7310		134	B
THALLIUM	10.0	4.0	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U
ZINC	20.0	3.0	9.0		3.0	U

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			DW-MW-HN-28X		DW-MW-HN-29I		DW-MW-HN-29S		DW-MW-HN-29X		DW-MW-HN-34X	
LABORATORY ID.			943275-21		943275-22		943275-23		943275-24		943275-25	

TAL AQUEOUS DISSOLVED METALS (ug/L)

ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	33.0	U	33.0	U	33.0	U	33.0	U
ANTIMONY	60.0	34.0	34.0	UL	34.0	UL	34.0	UL	36.7	L	34.0	UL
ARSENIC	10.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.7	K
BARIUM	200	7.0	306		317		141		107		242	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	31900		32800		51100		41900		28600	
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
COPPER	25.0	6.0	6.0	U	6.0	U	6.0	U	6.3		6.0	U
IRON	100	5.0	183		175		5.0	U	26.8		5.0	U
LEAD	3.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
MAGNESIUM	5000	27.0	12800		13200		14200		28000		7810	
MANGANESE	15.0	1.0	545		563		28.1		12.3		4.4	
MERCURY	0.20	0.10	0.13	U	0.13	U	0.14	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	806		885		1910		1360		855	
SELENIUM	5.0	4.0	4.0	UL	4.0	UL	4.0	UL	4.0	UL	4.0	UL
SILVER	10.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
SODIUM	5000	51.0	9810		10300		21200		15200		8680	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	3.0	U	3.0	U	44.4	B	15.4	B	7.8	B

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CEIMIC CORPORATION

CLIENT ID: DW-RB-11
LABORATORY ID: 943275-26

TAL AQUEOUS DISSOLVED METALS (ug/L)

ANALYTE	CRDL	IDL		
ALUMINUM	200	33.0	33.0	U
ANTIMONY	60.0	34.0	34.0	UL
ARSENIC	10.0	3.0	3.0	U
BARIUM	200	7.0	7.0	U
BERYLLIUM	5.0	1.0	1.0	U
CADMIUM	5.0	3.0	3.0	U
CALCIUM	5000	7.0	122	B
CHROMIUM	10.0	7.0	7.0	U
COBALT	50.0	4.0	4.0	U
COPPER	25.0	6.0	6.0	U
IRON	100	5.0	5.0	U
LEAD	3.0	1.0	10.5	
MAGNESIUM	5000	27.0	27.0	U
MANGANESE	15.0	1.0	1.2	
MERCURY	0.20	0.10	0.13	U
NICKEL	40.0	7.0	7.0	U
POTASSIUM	5000	10.0	10.0	U
SELENIUM	5.0	4.0	4.0	UL
SILVER	10.0	5.0	5.0	U
SODIUM	5000	51.0	389	B
THALLIUM	10.0	4.0	4.0	U
VANADIUM	50.0	3.0	3.0	U
ZINC	20.0	3.0	9.3	

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CEIMIC CORPORATION

TAL AQUEOUS DISSOLVED METALS (ug/L)

CLIENT ID:			DW-MW-BG-2		DW-MW-BG-6		DW-MW-DG-15		DW-MW-DG-16		DW-MW-DG-22	
LABORATORY ID:			941275-01		941275-02		941275-06		941275-07		941275-08	
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	372		33.0	U	33.0	U	33.0	U	33.0	U
ANTIMONY	60.0	34.0	34.0	UL	37.0	L	34.0	UL	34.0	UL	45.9	L
ARSENIC	10.0	3.0	3.0	UL	3.0	UL	3.0	UJ	3.0	UJ	3.0	UJ
BARIUM	200	7.0	47.8		45.7		301		452		371	K
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	UL	3.0	UL	3.0	UL
CALCIUM	5000	7.0	11500	J	9070	J	64000	J	53000	J	49400	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	4.1	B	4.0	UL	4.0	UL
COPPER	25.0	6.0	7.1	K	6.0	U	6.0	U	6.0	U	6.0	U
IRON	100	5.0	13700		5.0	U	17.7		5.0	U	5.0	U
LEAD	3.0	1.0	1.7	J	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ
MAGNESIUM	5000	27.0	5020	J	2790	J	10300	J	17200	J	12000	J
MANGANESE	15.0	1.0	452		27.4		1380		3.5	K	27.6	K
MERCURY	0.20	0.10	0.13	U	0.33		0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	8.9	B	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	2220		954		1030		1520		1510	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	5380		13700		11400		10900		10300	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.6		3.0	U	3.0	UL	3.0	UL	3.0	UL
ZINC	20.0	3.0	26.8		11.7		8.5	L	9.3	L	3.0	UL

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CEIMIC CORPORATION

CLIENT ID			DW-MW-DG-24		DW-MW-DG-28		DW-MW-DG-4		DW-MW-DG-5		DW-MW-DG-6	
LABORATORY ID			941275-09		941275-10		941275-03		941275-04		941275-05	
TAL AQUEOUS DISSOLVED METALS (ug/L)												
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	33.0	U	33.0	U	33.0	U	33.0	U
ANTIMONY	60.0	34.0	50.9	L	53.6	L	35.2	L	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.0	UJ	3.0	UL	3.0	UJ	3.0	UJ	3.0	UJ
BARIUM	200	7.0	232		80.1		552		92.9		243	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	UL	3.0	U	4.3	J	3.0	UL	3.0	UL
CALCIUM	5000	7.0	63500	J	33700	J	28300	J	56400	J	58600	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	UL	4.0	U	4.1	B	4.0	UL	4.0	UL
COPPER	25.0	6.0	6.0	U	8.3		6.0	U	6.0	U	6.0	U
IRON	100	5.0	5.0	U	5.0	U	18200		1620		11500	
LEAD	3.0	1.0	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ
MAGNESIUM	5000	27.0	9390	J	11900	J	7150	J	11200	J	9330	J
MANGANESE	15.0	1.0	61.5		1.4		1060		1080		553	
MERCURY	0.20	0.10	0.14	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	11.2	B	7.0	U	12.4	B
POTASSIUM	5000	10.0	865		875		1370		1150		1170	
SELENIUM	5.0	4.0	4.0	UJ	4.0	U	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	11300		7350		11300		13000		10700	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	UL	3.0	U	3.0	UL	3.0	UL	3.0	UL
ZINC	20.0	3.0	3.0	UL	5.8		7.6	L	3.0	UL	47.0	

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CEIMIC CORPORATION

CLIENT ID:			DW-MW-HN-23I		DW-MW-HN-23S		DW-MW-HN-23X		DW-MW-HN-24I		DW-MW-HN-24S	
LABORATORY ID.			941275-11		941275-12		941275-13		941275-14		941275-15	
TAL AQUEOUS DISSOLVED METALS (ug/L)												
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	33.0	U	33.0	U	363		33.0	U
ANTIMONY	60.0	34.0	34.0	UL	37.0	L	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.0	UL	3.0	UL	3.0	UL	5.4	L	3.0	UJ
BARIUM	200	7.0	231		204		56.1		272		213	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	UL
CALCIUM	5000	7.0	25000	J	26700	J	35900	J	35100	J	46300	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	13.6	B	4.0	U	4.1	B
COPPER	25.0	6.0	6.0	U	6.0	U	6.2	K	6.5	K	6.0	U
IRON	100	5.0	9.1		5.0	U	5.6		557		5.0	U
LEAD	3.0	1.0	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ
MAGNESIUM	5000	27.0	15600	J	7220	J	15800	J	12000	J	17300	J
MANGANESE	15.0	1.0	1.0	U	1.6		446		25.7		20.2	K
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	8.1	B	34.4	B	7.0	U	7.0	U
POTASSIUM	5000	10.0	1000		747		757		1040		885	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	8510		8210		11900		34600		12800	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	UL
ZINC	20.0	3.0	3.0	U	5.1		26.9		28.1		3.5	L

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CEIMIC CORPORATION

TAL AQUEOUS DISSOLVED METALS (ug/L)

CLIENT ID:			DW-MW-HN-24X		DW-MW-HN-25I		DW-MW-HN-25S		DW-MW-HN-28I		DW-MW-HN-28S	
LABORATORY ID:			941275-16		941275-17		941275-18		941275-19		941275-20	
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	33.0	U	33.0	U	33.0	U	48.5	B
ANTIMONY	60.0	34.0	34.0	UL	56.0	L	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	5.4	L	3.0	UL	3.0	UL	3.0	UL	10.9	L
BARIUM	200	7.0	172		158		28.4		282		132	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	5.5	K	3.0	U	3.0	U
CALCIUM	5000	7.0	35000	J	35200	J	30200	J	33000	J	22100	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.1	B	4.0	U	4.1	B	4.0	U
COPPER	25.0	6.0	6.5	K	7.7	K	7.2	K	6.0	U	6.0	U
IRON	100	5.0	5.0	U	5.0	U	5.0	U	263		44.0	
LEAD	3.0	1.0	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ
MAGNESIUM	5000	27.0	12000	J	9110	J	5260	J	12100	J	9520	J
MANGANESE	15.0	1.0	13.5		183		60.3		653		18.4	
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	944		1000		954		914		1730	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	33700		10700		26400		9470		24700	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	4.6		21.1		18.9		3.0	U	4.8	

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CEIMIC CORPORATION

CLIENT ID:			DW-FBC1		DW-FBC2		DW-MW-BG5		DW-MW-DG14		DW-MW-HN26I	
LABORATORY ID.			941285-01		941285-02		941285-03		941285-04		941285-05	

TAL AQUEOUS DISSOLVED METALS (ug/L)

ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	46.2	B	44.2	B	33.0	U	33.0	U
ANTIMONY	60.0	34.0	35.4	J	34.0	UJ	59.5	J	39.0	J	64.7	J
ARSENIC	10.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	4.3	B
BARIUM	200	7.0	25.7		7.0	U	122		92.1		157	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	17500		133	B	13800		16900		22300	
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	9.7	B	8.7	B
COBALT	50.0	4.0	5.3	B	4.0	U	4.0	U	4.0	U	6.1	B
COPPER	25.0	6.0	270		6.0	U	6.0	U	6.0	U	8.0	
IRON	100	5.0	14.8	B	17.4	B	18.4	B	15.6	B	17.9	B
LEAD	3.0	1.0	1.0	UL	1.0	UL	1.0	UL	1.0	UL	1.0	UL
MAGNESIUM	5000	27.0	6000		34.4	B	4330		4850		13200	
MANGANESE	15.0	1.0	20.9		2.1	B	6.0	B	2.4	B	5.6	B
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.14	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	1770		172	B	1010		761	B	1240	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL	6.3	L	5.0	UL	5.0	UL
SODIUM	5000	51.0	10800		180	B	6040		8310		11900	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.8	
ZINC	20.0	3.0	54.2		3.0	U	6.1		6.1		3.0	U

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CEIMIC CORPORATION

CLIENT ID:			DW-MW-HN26S		DW-MW-HN27I		DW-MW-HN27S		DW-MW-HN34S		DW-MW-MW1	
LABORATORY ID:			941285-06		941285-07		941285-08		941285-09		941285-10	
TAL AQUEOUS DISSOLVED METALS (ug/L)												
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	33.0	U	33.0	U	33.0	U	33.0	U
ANTIMONY	60.0	34.0	34.0	UJ	34.0	UJ	62.0	J	45.9	J	34.0	UJ
ARSENIC	10.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
BARIUM	200	7.0	122		349		59.6		125		175	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	18900		31800		16700		35000		20000	
CHROMIUM	10.0	7.0	7.0	U	9.3	B	8.3	B	11.0	B	10.0	B
COBALT	50.0	4.0	5.3	B	5.0	B	4.0	U	4.2	B	4.0	U
COPPER	25.0	6.0	6.0	U	7.7		6.0	U	17.3		6.1	
IRON	100	5.0	11.0	B	23.2	B	27.7	B	26.0	B	14.8	B
LEAD	3.0	1.0	1.0	UL	1.0	UL	1.0	UL	1.0	UL	1.0	UL
MAGNESIUM	5000	27.0	6850		13100		7290		12300		4970	
MANGANESE	15.0	1.0	57.6		68.1		11.5		9.4		2.8	B
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	8.6	B	7.0	U
POTASSIUM	5000	10.0	1190		1580		1730		1110		888	B
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	8900		10600		12100		9360		7240	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	7.2		15.4		10.5		8.5		6.5	

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CEIMIC CORPORATION

CLIENT ID.			DW-MW-MW2		DW-RB12	
LABORATORY ID			941285-11		941285-12	

TAL AQUEOUS DISSOLVED METALS (ug/L)

ANALYTE	CRDL	IDL				
ALUMINUM	200	33.0	33.0	U	35.0	
ANTIMONY	60.0	34.0	34.0	UJ	34.0	UJ
ARSENIC	10.0	3.0	3.0	U	3.0	U
BARIUM	200	7.0	165		7.0	U
BERYLLIUM	5.0	1.0	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U
CALCIUM	5000	7.0	19700		105	
CHROMIUM	10.0	7.0	7.5	B	9.3	B
COBALT	50.0	4.0	4.0	U	4.0	U
COPPER	25.0	6.0	6.0	U	6.0	U
IRON	100	5.0	15.9	B	19.1	B
LEAD	3.0	1.0	15.9		1.0	UL
MAGNESIUM	5000	27.0	4990		27.0	U
MANGANESE	15.0	1.0	4.3	B	1.3	B
MERCURY	0.20	0.10	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U
POTASSIUM	5000	10.0	834	B	118	B
SELENIUM	5.0	4.0	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL
SODIUM	5000	51.0	7300		169	B
THALLIUM	10.0	4.0	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U
ZINC	20.0	3.0	5.6		3.0	U

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CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-28		XW-MW-HN-29I		W-MW-HN-29		SW-MW-HN-29		XW-MW-HN-34X	
LABORATORY ID:			940275-21		940275-22		940275-23		940275-24		940275-25	
ANALYTE	CRQL	MDL										
PHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U	10	U	10	U	10	U	10	U
2-CHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
1,4-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
1,2-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U	10	U	10	U	10	U	10	U
4-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROETHANE	10	1	10	U	10	U	10	U	10	U	10	U
NITROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
ISOPHORONE	10	1	10	U	10	U	10	U	10	U	10	U
2-NITROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
NAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
4-CHLOROANILINE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROBUTADIENE	10	1	10	U	10	U	10	U	10	U	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	U	10	U	10	U	10	U	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
2-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	U
DIMETHYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
ACENAPHTHYLENE	10	1	10	U	10	U	10	U	10	U	10	U
2,6-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	U
3-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	U
ACENAPHTHENE	10	1	10	U	10	U	10	U	10	U	10	U

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CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-28X		W-MW-HN-29I		W-MW-HN-29S		W-MW-HN-29X		W-MW-HN-34X	
LABORATORY ID:			940275-21		940275-22		940275-23		940275-24		940275-25	
ANALYTE	CRQL	MDL										
2,4-DINITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
DIBENZOFURAN	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	U
DIETHYL PHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	U
FLUORENE	10	1	10	U	10	U	10	U	10	U	10	U
4-NITROANILINE	25	2.5	25	UJ	25	UJ	25	UJ	25	UJ	25	UJ
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U	10	U	10	U	10	U	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
PENTACHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
PHENANTHRENE	10	1	10	U	10	U	10	U	10	U	10	U
ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
DI-n-BUTYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
CARBAZOLE	10	1	10	U	10	U	10	U	10	U	10	U
PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
BUTYLBENZYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(a)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
CHRYSENE	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	2	B	1	B	3	B	3	B	18	B
DI-n-OCTYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(b)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(k)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(a)PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
INDENO(1,2,3-cd)PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
DIBENZO(a,h)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(g,h,i)PERYLENE	10	1	10	U	10	U	10	U	10	U	10	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID: W-RB-11
LABORATORY ID: 940275-26

ANALYTE	CRQL	MDL		
PHENOL	10	1	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U
2-CHLOROPHENOL	10	1	10	U
1,3-DICHLOROBENZENE	10	1	10	U
1,4-DICHLOROBENZENE	10	1	10	U
1,2-DICHLOROBENZENE	10	1	10	U
2-METHYLPHENOL	10	1	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U
4-METHYLPHENOL	10	1	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U
HEXACHLOROETHANE	10	1	10	U
NITROBENZENE	10	1	10	U
ISOPHORONE	10	1	10	U
2-NITROPHENOL	10	1	10	U
2,4-DIMETHYLPHENOL	10	1	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U
2,4-DICHLOROPHENOL	10	1	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U
NAPHTHALENE	10	1	10	U
4-CHLOROANILINE	10	1	10	U
HEXACHLOROBUTADIENE	10	1	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U
2-METHYLNAPHTHALENE	10	1	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U
2-CHLORONAPHTHALENE	10	1	10	U
2-NITROANILINE	25	2.5	25	U
DIMETHYLPHTHALATE	10	1	10	U
ACENAPHTHYLENE	10	1	10	U
2,6-DINITROTOLUENE	10	1	10	U
3-NITROANILINE	25	2.5	25	U
ACENAPHTHENE	10	1	10	U

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-RB-11	
LABORATORY ID:			940275-26	
ANALYTE	CRQL	MDL		
2,4-DINITROPHENOL	25	2.5	25	U
4-NITROPHENOL	25	2.5	25	U
DIBENZOFURAN	10	1	10	U
2,4-DINITROTOLUENE	10	1	10	U
DIETHYL PHTHALATE	10	1	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U
FLUORENE	10	1	10	U
4-NITROANILINE	25	2.5	25	U
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U
HEXACHLOROBENZENE	10	1	10	U
PENTACHLOROPHENOL	25	2.5	25	U
PHENANTHRENE	10	1	10	U
ANTHRACENE	10	1	10	U
DI-n-BUTYLPHTHALATE	10	1	10	U
FLUORANTHENE	10	1	10	U
CARBAZOLE	10	1	10	UJ
PYRENE	10	1	10	U
BUTYLBENZYLPHTHALATE	10	1	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	UJ
BENZO(a)ANTHRACENE	10	1	10	U
CHRYSENE	10	1	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	5	J
DI-n-OCTYLPHTHALATE	10	1	10	U
BENZO(b)FLUORANTHENE	10	1	10	U
BENZO(k)FLUORANTHENE	10	1	10	U
BENZO(a)PYRENE	10	1	10	U
INDENO(1,2,3-cd)PYRENE	10	1	10	U
DIBENZO(a,h)ANTHRACENE	10	1	10	U
BENZO(g,h,i)PERYLENE	10	1	10	U
DILUTION FACTOR:			1.0	

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			DW-MW-MW2		DW-RB12	
LABORATORY ID			941285-11		941285-12	

TAL AQUEOUS DISSOLVED METALS (ug/L)

ANALYTE	CRDL	IDL				
ALUMINUM	200	33.0	33.0	U	35.0	
ANTIMONY	60.0	34.0	34.0	UJ	34.0	UJ
ARSENIC	10.0	3.0	3.0	U	3.0	U
BARIUM	200	7.0	165		7.0	U
BERYLLIUM	5.0	1.0	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U
CALCIUM	5000	7.0	19700		105	
CHROMIUM	10.0	7.0	7.5	B	9.3	B
COBALT	50.0	4.0	4.0	U	4.0	U
COPPER	25.0	6.0	6.0	U	6.0	U
IRON	100	5.0	15.9	B	19.1	B
LEAD	3.0	1.0	15.9		1.0	UL
MAGNESIUM	5000	27.0	4990		27.0	U
MANGANESE	15.0	1.0	4.3	B	1.3	B
MERCURY	0.20	0.10	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U
POTASSIUM	5000	10.0	834	B	118	B
SELENIUM	5.0	4.0	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL
SODIUM	5000	51.0	7300		169	B
THALLIUM	10.0	4.0	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U
ZINC	20.0	3.0	5.6		3.0	U

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TAL AQUEOUS DISSOLVED METALS (ug/L)

CLIENT ID:			DW-MW-HN26S		DW-MW-HN27I		DW-MW-HN27S		DW-MW-HN34S		DW-MW-MW1	
LABORATORY ID			941285-06		941285-07		941285-08		941285-09		941285-10	
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	33.0	U	33.0	U	33.0	U	33.0	U
ANTIMONY	60.0	34.0	34.0	UJ	34.0	UJ	62.0	J	45.9	J	34.0	UJ
ARSENIC	10.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
BARIUM	200	7.0	122		349		59.6		125		175	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	18900		31800		16700		35000		20000	
CHROMIUM	10.0	7.0	7.0	U	9.3	B	8.3	B	11.0	B	10.0	B
COBALT	50.0	4.0	5.3	B	5.0	B	4.0	U	4.2	B	4.0	U
COPPER	25.0	6.0	6.0	U	7.7		6.0	U	17.3		6.1	
IRON	100	5.0	11.0	B	23.2	B	27.7	B	26.0	B	14.8	B
LEAD	3.0	1.0	1.0	UL	1.0	UL	1.0	UL	1.0	UL	1.0	UL
MAGNESIUM	5000	27.0	6850		13100		7290		12300		4970	
MANGANESE	15.0	1.0	57.6		68.1		11.5		9.4		2.8	B
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	8.6	B	7.0	U
POTASSIUM	5000	10.0	1190		1580		1730		1110		888	B
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	8900		10600		12100		9360		7240	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	7.2		15.4		10.5		8.5		6.5	

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CEIMIC CORPORATION

CLIENT ID.			DW-FBC1		DW-FBC2		DW-MW-BG5		DW-MW-DG14		DW-MW-HN26I	
LABORATORY ID.			941285-01		941285-02		941285-03		941285-04		941285-05	

TAL AQUEOUS DISSOLVED METALS (ug/L)

ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	46.2	B	44.2	B	33.0	U	33.0	U
ANTIMONY	60.0	34.0	35.4	J	34.0	UJ	59.5	J	39.0	J	64.7	J
ARSENIC	10.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	4.3	B
BARIUM	200	7.0	25.7		7.0	U	122		92.1		157	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	17500		133	B	13800		16900		22300	
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	9.7	B	8.7	B
COBALT	50.0	4.0	5.3	B	4.0	U	4.0	U	4.0	U	6.1	B
COPPER	25.0	6.0	270		6.0	U	6.0	U	6.0	U	8.0	
IRON	100	5.0	14.8	B	17.4	B	18.4	B	15.6	B	17.9	B
LEAD	3.0	1.0	1.0	UL	1.0	UL	1.0	UL	1.0	UL	1.0	UL
MAGNESIUM	5000	27.0	6000		34.4	B	4330		4850		13200	
MANGANESE	15.0	1.0	20.9		2.1	B	6.0	B	2.4	B	5.6	B
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.14	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	1770		172	B	1010		761	B	1240	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL	6.3	L	5.0	UL	5.0	UL
SODIUM	5000	51.0	10800		180	B	6040		8310		11900	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.8	
ZINC	20.0	3.0	54.2		3.0	U	6.1		6.1		3.0	U

CTO-159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			DW-MW-HN-24X		DW-MW-HN-25I		DW-MW-HN-25S		DW-MW-HN-28I		DW-MW-HN-28S	
LABORATORY ID:			941275-16		941275-17		941275-18		941275-19		941275-20	

TAL AQUEOUS DISSOLVED METALS (ug/L)

ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	33.0	U	33.0	U	33.0	U	48.5	B
ANTIMONY	60.0	34.0	34.0	UL	56.0	L	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	5.4	L	3.0	UL	3.0	UL	3.0	UL	10.9	L
BARIUM	200	7.0	172		158		28.4		282		132	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	5.5	K	3.0	U	3.0	U
CALCIUM	5000	7.0	35000	J	35200	J	30200	J	33000	J	22100	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.1	B	4.0	U	4.1	B	4.0	U
COPPER	25.0	6.0	6.5	K	7.7	K	7.2	K	6.0	U	6.0	U
IRON	100	5.0	5.0	U	5.0	U	5.0	U	263		44.0	
LEAD	3.0	1.0	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ
MAGNESIUM	5000	27.0	12000	J	9110	J	5260	J	12100	J	9520	J
MANGANESE	15.0	1.0	13.5		183		60.3		653		18.4	
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	944		1000		954		914		1730	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	33700		10700		26400		9470		24700	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	4.6		21.1		18.9		3.0	U	4.8	

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CEIMIC CORPORATION

CLIENT ID:			DW-MW-HN-23I		DW-MW-HN-23S		DW-MW-HN-23X		DW-MW-HN-24I		DW-MW-HN-24S	
LABORATORY ID.			941275-11		941275-12		941275-13		941275-14		941275-15	

TAL AQUEOUS DISSOLVED METALS (ug/L)

ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	33.0	U	33.0	U	363		33.0	U
ANTIMONY	60.0	34.0	34.0	UL	37.0	L	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.0	UL	3.0	UL	3.0	UL	5.4	L	3.0	UJ
BARIUM	200	7.0	231		204		56.1		272		213	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	UL
CALCIUM	5000	7.0	25000	J	26700	J	35900	J	35100	J	46300	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	13.6	B	4.0	U	4.1	B
COPPER	25.0	6.0	6.0	U	6.0	U	6.2	K	6.5	K	6.0	U
IRON	100	5.0	9.1		5.0	U	5.6		557		5.0	U
LEAD	3.0	1.0	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ
MAGNESIUM	5000	27.0	15600	J	7220	J	15800	J	12000	J	17300	J
MANGANESE	15.0	1.0	1.0	U	1.6		446		25.7		20.2	K
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	8.1	B	34.4	B	7.0	U	7.0	U
POTASSIUM	5000	10.0	1000		747		757		1040		885	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	8510		8210		11900		34600		12800	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	UL
ZINC	20.0	3.0	3.0	U	5.1		26.9		28.1		3.5	L

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CEIMIC CORPORATION

TAL AQUEOUS DISSOLVED METALS (ug/L)

CLIENT ID			DW-MW-DG-24		DW-MW-DG-28		DW-MW-DG-4		DW-MW-DG-5		DW-MW-DG-6	
LABORATORY ID			941275-09		941275-10		941275-03		941275-04		941275-05	
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	33.0	U	33.0	U	33.0	U	33.0	U
ANTIMONY	60.0	34.0	50.9	L	53.6	L	35.2	L	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.0	UJ	3.0	UL	3.0	UJ	3.0	UJ	3.0	UJ
BARIUM	200	7.0	232		80.1		552		92.9		243	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	UL	3.0	U	4.3	J	3.0	UL	3.0	UL
CALCIUM	5000	7.0	63500	J	33700	J	28300	J	56400	J	58600	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	UL	4.0	U	4.1	B	4.0	UL	4.0	UL
COPPER	25.0	6.0	6.0	U	8.3		6.0	U	6.0	U	6.0	U
IRON	100	5.0	5.0	U	5.0	U	18200		1620		11500	
LEAD	3.0	1.0	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ
MAGNESIUM	5000	27.0	9390	J	11900	J	7150	J	11200	J	9330	J
MANGANESE	15.0	1.0	61.5		1.4		1060		1080		553	
MERCURY	0.20	0.10	0.14	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	11.2	B	7.0	U	12.4	B
POTASSIUM	5000	10.0	865		875		1370		1150		1170	
SELENIUM	5.0	4.0	4.0	UJ	4.0	U	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	11300		7350		11300		13000		10700	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	UL	3.0	U	3.0	UL	3.0	UL	3.0	UL
ZINC	20.0	3.0	3.0	UL	5.8		7.6	L	3.0	UL	47.0	

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID			DW-MW-BG-2		DW-MW-BG-6		DW-MW-DG-15		DW-MW-DG-16		DW-MW-DG-22	
LABORATORY ID			941275-01		941275-02		941275-06		941275-07		941275-08	
TAL AQUEOUS DISSOLVED METALS (ug/L)												
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	372		33.0	U	33.0	U	33.0	U	33.0	U
ANTIMONY	60.0	34.0	34.0	UL	37.0	L	34.0	UL	34.0	UL	45.9	L
ARSENIC	10.0	3.0	3.0	UL	3.0	UL	3.0	UJ	3.0	UJ	3.0	UJ
BARIUM	200	7.0	47.8		45.7		301		452		371	K
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	UL	3.0	UL	3.0	UL
CALCIUM	5000	7.0	11500	J	9070	J	64000	J	53000	J	49400	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	4.1	B	4.0	UL	4.0	UL
COPPER	25.0	6.0	7.1	K	6.0	U	6.0	U	6.0	U	6.0	U
IRON	100	5.0	13700		5.0	U	17.7		5.0	U	5.0	U
LEAD	3.0	1.0	1.7	J	1.0	UJ	1.0	UJ	1.0	UJ	1.0	UJ
MAGNESIUM	5000	27.0	5020	J	2790	J	10300	J	17200	J	12000	J
MANGANESE	15.0	1.0	452		27.4		1380		3.5	K	27.6	K
MERCURY	0.20	0.10	0.13	U	0.33		0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	8.9	B	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	2220		954		1030		1520		1510	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	5380		13700		11400		10900		10300	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.6		3.0	U	3.0	UL	3.0	UL	3.0	UL
ZINC	20.0	3.0	26.8		11.7		8.5	L	9.3	L	3.0	UL

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CEIMIC CORPORATION

CLIENT ID: DW-RB-11
LABORATORY ID. 943275-26

TAL AQUEOUS DISSOLVED METALS (ug/L)

ANALYTE	CRDL	IDL		
ALUMINUM	200	33.0	33.0	U
ANTIMONY	60.0	34.0	34.0	UL
ARSENIC	10.0	3.0	3.0	U
BARIUM	200	7.0	7.0	U
BERYLLIUM	5.0	1.0	1.0	U
CADMIUM	5.0	3.0	3.0	U
CALCIUM	5000	7.0	122	B
CHROMIUM	10.0	7.0	7.0	U
COBALT	50.0	4.0	4.0	U
COPPER	25.0	6.0	6.0	U
IRON	100	5.0	5.0	U
LEAD	3.0	1.0	10.5	
MAGNESIUM	5000	27.0	27.0	U
MANGANESE	15.0	1.0	1.2	
MERCURY	0.20	0.10	0.13	U
NICKEL	40.0	7.0	7.0	U
POTASSIUM	5000	10.0	10.0	U
SELENIUM	5.0	4.0	4.0	UL
SILVER	10.0	5.0	5.0	U
SODIUM	5000	51.0	389	B
THALLIUM	10.0	4.0	4.0	U
VANADIUM	50.0	3.0	3.0	U
ZINC	20.0	3.0	9.3	

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CEIMIC CORPORATION

CLIENT ID:			DW-MW-HN-28X		DW-MW-HN-29I		DW-MW-HN-29S		DW-MW-HN-29X		DW-MW-HN-34X	
LABORATORY ID			943275-21		943275-22		943275-23		943275-24		943275-25	

TAL AQUEOUS DISSOLVED METALS (ug/L)

ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	33.0	U	33.0	U	33.0	U	33.0	U
ANTIMONY	60.0	34.0	34.0	UL	34.0	UL	34.0	UL	36.7	L	34.0	UL
ARSENIC	10.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.7	K
BARIUM	200	7.0	306		317		141		107		242	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	31900		32800		51100		41900		28600	
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
COPPER	25.0	6.0	6.0	U	6.0	U	6.0	U	6.3		6.0	U
IRON	100	5.0	183		175		5.0	U	26.8		5.0	U
LEAD	3.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
MAGNESIUM	5000	27.0	12800		13200		14200		28000		7810	
MANGANESE	15.0	1.0	545		563		28.1		12.3		4.4	
MERCURY	0.20	0.10	0.13	U	0.13	U	0.14	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	806		885		1910		1360		855	
SELENIUM	5.0	4.0	4.0	UL	4.0	UL	4.0	UL	4.0	UL	4.0	UL
SILVER	10.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
SODIUM	5000	51.0	9810		10300		21200		15200		8680	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	3.0	U	3.0	U	44.4	B	15.4	B	7.8	B

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID.			W-MW-MW2		W-RB12	
LABORATORY ID.			940285-11		940285-12	

TAL AQUEOUS TOTAL METALS (ug/L)

ANALYTE	CRDL	IDL				
ALUMINUM	200	33.0	481		33.0	U
ANTIMONY	60.0	34.0	34.0	UJ	64.1	J
ARSENIC	10.0	3.0	3.0	U	3.0	U
BARIUM	200	7.0	213		7.0	U
BERYLLIUM	5.0	1.0	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U
CALCIUM	5000	7.0	19900		80.8	B
CHROMIUM	10.0	7.0	14.7	B	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U
COPPER	25.0	6.0	6.8		6.0	U
IRON	100	5.0	864		12.0	B
LEAD	3.0	1.0	1.0	UL	1.0	UL
MAGNESIUM	5000	27.0	5040		27.0	U
MANGANESE	15.0	1.0	131		1.1	B
MERCURY	0.20	0.10	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U
POTASSIUM	5000	10.0	797	B	109	B
SELENIUM	5.0	4.0	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL
SODIUM	5000	51.0	7310		134	B
THALLIUM	10.0	4.0	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U
ZINC	20.0	3.0	9.0		3.0	U

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-MW-HN26S		W-MW-HN27I		W-MW-HN27S		W-MW-HN34S		W-MW-MW1	
LABORATORY ID.			940285-06		940285-07		940285-08		940285-09		940285-10	

TAL AQUEOUS TOTAL METALS (ug/L)

ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	2100		189		83.9		200		668	
ANTIMONY	60.0	34.0	57.5	B	34.0	UJ	50.0	B	34.0	UJ	34.0	UJ
ARSENIC	10.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
BARIUM	200	7.0	223		376		154		179		211	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	18500		31800		16600		39900		20100	
CHROMIUM	10.0	7.0	7.5	B	7.0	U	13.2	B	7.0	U	10.6	B
COBALT	50.0	4.0	4.0	U	4.0	U	5.0	B	5.0	B	6.1	B
COPPER	25.0	6.0	10.4		6.0	U	7.7		25.8		6.6	
IRON	100	5.0	1770		238		68.8	B	337		1040	
LEAD	3.0	1.0	1.7	L	1.0	UL	1.0	UL	2.7	L	1.0	UL
MAGNESIUM	5000	27.0	6980		13300		7270		14100		5240	
MANGANESE	15.0	1.0	266		85.2		14.7		26.1		140	
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	1150		1620		1680		1200		915	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	8330		10700		12100		10600		7650	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.1		3.0	U	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	14.1		29.2		11.4		48.8		8.4	

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CEIMIC CORPORATION

CLIENT ID:			W-FBC1		W-FBC2		W-MW-BG5		W-MW-DG14		W-MW-HN26I	
LABORATORY ID:			940285-01		940285-02		940285-03		940285-04		940285-05	

TAL AQUEOUS TOTAL METALS (ug/L)

ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	79.8		366		121		33.0	U	131	
ANTIMONY	60.0	34.0	41.0	B	38.9	B	34.0	UJ	34.0	UJ	34.0	UJ
ARSENIC	10.0	3.0	3.1	B	3.0	U	3.0	U	3.0	U	3.0	U
BARIUM	200	7.0	28.3		7.0	U	154		101		175	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	18100		576		15000		17200		21200	
CHROMIUM	10.0	7.0	11.0	B	12.3	B	12.0	B	12.6	B	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.2	B
COPPER	25.0	6.0	395		6.0	U	8.5		7.3		6.0	U
IRON	100	5.0	42.4	B	333		107		45.7	B	79.4	B
LEAD	3.0	1.0	1.7	L	1.0	UL	1.0	UL	1.0	UL	1.0	UL
MAGNESIUM	5000	27.0	6220		1350		4710		4980		12700	
MANGANESE	15.0	1.0	23.9		2.0	B	66.2		2.6	B	6.2	B
MERCURY	0.20	0.10	0.13	U	0.24		0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
POTASSIUM	5000	10.0	1780		417	B	924		761	B	1130	
SELENIUM	5.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	11200		148	B	6530		8560		11500	
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	60.0		3.0		9.8		25.0		16.2	

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CEIMIC CORPORATION

CLIENT ID:			W-MW-HN-24X		W-MW-HN-25I		W-MW-HN-25S		W-MW-HN-28I		W-MW-HN-28S	
LABORATORY ID:			940275-16		940275-17		940275-18		940275-19		940275-20	
TAL AQUEOUS TOTAL METALS (ug/L)												
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	393		677		6920		60.2		2340	
ANTIMONY	60.0	34.0	34.0	UL	34.0	UL	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	7.1		3.0	U	5.0		3.9		13.6	
BARIUM	200	7.0	243	J	234	J	554	J	351	J	198	J
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.5		1.0	U	1.0	U
CADMIUM	5.0	3.0	3.4	K	4.3	K	4.4	K	3.0	U	3.0	U
CALCIUM	5000	7.0	36400	J	38700	J	35900	J	35600	J	23200	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	14.0	K	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
COPPER	25.0	6.0	7.1		19.8		13.1		6.0	U	6.0	U
IRON	100	5.0	513	J	1090	J	3150	J	576	J	1440	J
LEAD	3.0	1.0	1.0		6.7		10.9		1.0	U	3.1	
MAGNESIUM	5000	27.0	12400	J	9980	J	6820	J	12900	J	10200	J
MANGANESE	15.0	1.0	26.6		235		354		719		46.0	
MERCURY	0.20	0.10	0.13	U	0.20		0.22		0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	10.4	B	8.6	B	7.0	U	7.0	U
POTASSIUM	5000	10.0	1120	J	1350	J	1380	J	1070	J	1940	J
SELENIUM	5.0	4.0	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	35200	J	11700	J	25900	J	9810	J	24000	J
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.3	B	3.0	U	4.5	B	3.0	U	4.8	B
ZINC	20.0	3.0	27.6	B	39.1	B	58.5	B	23.6	B	24.5	B

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CEIMIC CORPORATION

CLIENT ID:			W-MW-HN-23I		W-MW-HN-23S		W-MW-HN-23X		W-MW-HN-24I		W-MW-HN-24S	
LABORATORY ID:			940275-11		940275-12		940275-13		940275-14		940275-15	
TAL AQUEOUS TOTAL METALS (ug/L)												
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	104		171		11600		33.0	U	138	
ANTIMONY	60.0	34.0	34.0	UL	34.0	UL	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.2		3.0	U	3.5		5.2		4.1	
BARIUM	200	7.0	235	J	275	J	219	J	181	J	292	J
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.1		1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.8	K	3.0	U	3.0	U
CALCIUM	5000	7.0	25300	J	28300	J	38600	J	35400	J	48400	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	13.4	K	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	UL	4.0	U	16.5		4.0	U	4.0	UL
COPPER	25.0	6.0	6.0	U	13.4		16.0		6.0	U	6.0	U
IRON	100	5.0	78.8	B	155	B	12500	J	49.8	B	105	B
LEAD	3.0	1.0	1.0	U	1.3		6.0		1.0	U	1.0	U
MAGNESIUM	5000	27.0	15600	J	7620	J	19900	J	12100	J	17900	J
MANGANESE	15.0	1.0	4.4	B	13.6		651		15.2		22.4	
MERCURY	0.20	0.10	0.13	U	0.13	U	0.13	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	19.0	B	7.0	U	7.0	U
POTASSIUM	5000	10.0	1160	J	952	J	1420	J	1060	J	1010	J
SELENIUM	5.0	4.0	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	8260	J	8350	J	12700	J	34200	J	13300	J
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	U	4.0	U	4.0	UL
VANADIUM	50.0	3.0	3.0	U	3.0	U	20.9		3.0	U	3.0	U
ZINC	20.0	3.0	30.2	B	21.6	B	56.9	B	9.1	B	13.1	B

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CEIMIC CORPORATION

CLIENT ID:			W-MW-DG-24		W-MW-DG-28		W-MW-DG-4		W-MW-DG-5		W-MW-DG-6	
LABORATORY ID:			940275-09		940275-10		940275-03		940275-04		940275-05	
TAL AQUEOUS TOTAL METALS (ug/L)												
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	171		453		366		999		639	
ANTIMONY	60.0	34.0	34.0	UL	34.0	UL	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.0	U	3.0	U	3.2		3.2		3.0	U
BARIUM	200	7.0	244	J	76.3	J	593	J	182	J	250	J
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.2	K	3.3	K	3.0	U	3.0	U
CALCIUM	5000	7.0	64900	J	30100	J	27000	J	60100	J	56300	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	8.0	K	7.0	U
COBALT	50.0	4.0	4.0	UL	4.0	U	4.0	U	4.0	UL	4.0	UL
COPPER	25.0	6.0	6.0	U	9.6		7.7		14.4		7.0	
IRON	100	5.0	204	J	572	J	35200	J	12500	J	17300	J
LEAD	3.0	1.0	1.0	U	1.0	U	3.2		3.2		3.5	
MAGNESIUM	5000	27.0	9500	J	10600	J	6820	J	12000	J	8980	J
MANGANESE	15.0	1.0	165		81.0		1030		1180		547	
MERCURY	0.20	0.10	0.14	U	0.13	U	0.13		0.13	U	0.15	
NICKEL	40.0	7.0	7.0	U	7.0	U	14.4	B	9.0	B	10.1	B
POTASSIUM	5000	10.0	971	J	877	J	1330	J	1180	J	1230	J
SELENIUM	5.0	4.0	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	11300	J	6690	J	10800	J	14000	J	10200	J
THALLIUM	10.0	4.0	4.0	UL	4.0	U	4.0	U	4.0	UL	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	8.6	B	5.2	B	5.4	B
ZINC	20.0	3.0	16.8	B	7.5	B	51.0	B	19.9	B	225	J

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CLIENT ID:			W-MW-BG-2		W-MW-BG-6		W-MW-DG-15		W-MW-DG-16		W-MW-DG-22	
LABORATORY ID:			940275-01		940275-02		940275-06		940275-07		940275-08	

TAL AQUEOUS TOTAL METALS (ug/L)

ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	33.0	U	7370		169		383		79.2	
ANTIMONY	60.0	34.0	34.0	UL	34.0	UL	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.0	U	5.9		3.1		4.4		3.0	U
BARIUM	200	7.0	40.8	J	114	J	329	J	442	J	381	J
BERYLLIUM	5.0	1.0	1.0	U	1.5		1.0	U	1.0	U	1.0	U
CADMIUM	5.0	3.0	3.0	U	3.8	K	3.0	U	3.0	U	3.2	K
CALCIUM	5000	7.0	11900	J	15200	J	67700	J	51700	J	50700	J
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	7.0	U	7.0	U
COBALT	50.0	4.0	4.0	U	4.1		4.0	UL	4.0	UL	4.0	UL
COPPER	25.0	6.0	7.8		10.1		6.0	U	6.0	U	6.0	U
IRON	100	5.0	5650	J	3130	J	172	B	590	J	125	B
LEAD	3.0	1.0	1.0	U	11.9		1.0	U	1.0	U	1.0	U
MAGNESIUM	5000	27.0	5130	J	5450	J	10900	J	16800	J	12200	J
MANGANESE	15.0	1.0	451		89.9		1720		20.2		106	
MERCURY	0.20	0.10	0.13	U	0.17		0.14	U	0.13	U	0.13	U
NICKEL	40.0	7.0	10.3	B	7.0	U	7.0	U	9.1	B	7.0	U
POTASSIUM	5000	10.0	2360	J	1350	J	1220	J	1760	J	1590	J
SELENIUM	5.0	4.0	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ	4.0	UJ
SILVER	10.0	5.0	5.0	UL	5.0	UL	5.0	UL	5.0	UL	5.0	UL
SODIUM	5000	51.0	5370	J	12700	J	12100	J	10500	J	10300	J
THALLIUM	10.0	4.0	4.0	U	4.0	U	4.0	UL	4.0	UL	4.0	UL
VANADIUM	50.0	3.0	3.0	U	4.5	B	3.0	U	3.0	U	3.0	U
ZINC	20.0	3.0	10.3	B	38.4	B	21.2	B	10.8	B	17.4	B

CTO 159 NAWC WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TAL AQUEOUS TOTAL METALS (ug/L)

CLIENT ID:			W-RB-11	
LABORATORY ID:			942275-26	
ANALYTE	CRDL	IDL		
ALUMINUM	200	33.0	33.0	U
ANTIMONY	60.0	34.0	34.0	UL
ARSENIC	10.0	3.0	3.0	U
BARIUM	200	7.0	7.0	U
BERYLLIUM	5.0	1.0	1.0	U
CADMIUM	5.0	3.0	3.0	U
CALCIUM	5000	7.0	122	B
CHROMIUM	10.0	7.0	7.0	U
COBALT	50.0	4.0	4.0	U
COPPER	25.0	6.0	6.0	U
IRON	100	5.0	46.9	B
LEAD	3.0	1.0	1.3	
MAGNESIUM	5000	27.0	34.6	B
MANGANESE	15.0	1.0	1.0	U
MERCURY	0.20	0.10	0.13	U
NICKEL	40.0	7.0	7.0	U
POTASSIUM	5000	10.0	10.0	U
SELENIUM	5.0	4.0	4.0	UL
SILVER	10.0	5.0	5.0	U
SODIUM	5000	51.0	232	B
THALLIUM	10.0	4.0	4.0	U
VANADIUM	50.0	3.0	3.0	U
ZINC	20.0	3.0	36.3	

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TAL AQUEOUS TOTAL METALS (ug/L)

CLIENT ID:			W-MW-HN-28X		W-MW-HN-29I		W-MW-HN-29S		W-MW-HN-29X		W-MW-HN-34X	
LABORATORY ID:			942275-21		942275-22		942275-23		942275-24		942275-25	
ANALYTE	CRDL	IDL										
ALUMINUM	200	33.0	45.9		33.0	U	225		20900		99.5	
ANTIMONY	60.0	34.0	47.3	L	34.0	UL	34.0	UL	34.0	UL	34.0	UL
ARSENIC	10.0	3.0	3.0	U	3.5	K	3.0	K	6.6	K	5.4	K
BARIUM	200	7.0	380		342		216		253		265	
BERYLLIUM	5.0	1.0	1.0	U	1.0	U	1.0	U	1.1		1.0	U
CADMIUM	5.0	3.0	3.0	U	3.0	U	3.0	U	3.0	U	3.0	U
CALCIUM	5000	7.0	33800		33500		54500		43500		27800	
CHROMIUM	10.0	7.0	7.0	U	7.0	U	7.0	U	15.5		7.0	U
COBALT	50.0	4.0	4.0	U	4.0	U	4.0	U	18.6	B	4.1	B
COPPER	25.0	6.0	6.0	U	6.0	U	7.7	K	79.2		7.6	K
IRON	100	5.0	293		276		206	B	15400		120	B
LEAD	3.0	1.0	1.0	U	1.0	U	1.0	U	6.1	B	2.1	B
MAGNESIUM	5000	27.0	13600		13500		15200		33700		7570	
MANGANESE	15.0	1.0	578		575		67.6		1840		13.5	
MERCURY	0.20	0.10	0.13	U	0.13	U	0.14	U	0.13	U	0.13	U
NICKEL	40.0	7.0	7.0	U	7.0	U	7.0	U	25.7	B	7.0	U
POTASSIUM	5000	10.0	836		796		2000		2040		865	
SELENIUM	5.0	4.0	4.0	UL	4.0	UL	4.0	UL	4.0	UL	4.0	UL
SILVER	10.0	5.0	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
SODIUM	5000	51.0	10600		10400		22400		17400		8550	
THALLIUM	10.0	4.0	4.0	U	5.1		4.0	U	4.0	U	4.0	U
VANADIUM	50.0	3.0	3.0	U	3.0	U	3.0	U	21.7		3.0	U
ZINC	20.0	3.0	3.0	U	3.0	U	71.3		47.8		46.2	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-MW-HN27S		W-MW-HN34S		W-RB12	
LABORATORY ID:			940285-08		940285-09		940285-12	
ANALYTE	CRQL	MDL						
alpha-BHC	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
beta-BHC	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
delta-BHC	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
gamma-BHC (LINDANE)	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
HEPTACHLOR	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
ALDRIN	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
ENDOSULFAN I	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
DIELDRIN	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
4,4'-DDE	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
ENDRIN	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
ENDOSULFAN II	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
4,4'-DDD	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
ENDOSULFAN SULFATE	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
4,4'-DDT	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
METHOXYCHLOR	0.50	0.10	0.50	UL	0.50	UL	0.50	UL
ENDRIN KETONE	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
ENDRIN ALDEHYDE	0.10	0.020	0.10	UL	0.10	UL	0.10	UL
alpha-CHLORDANE	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
gamma-CHLORDANE	0.050	0.010	0.050	UL	0.050	UL	0.050	UL
TOXAPHENE	5.0	1.67	5.0	UL	5.0	UL	5.0	UL
AROCLOR-1016	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1221	2.0	0.67	2.0	UL	2.0	UL	2.0	UL
AROCLOR-1232	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1242	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1248	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1254	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1260	1.0	0.33	1.0	UL	1.0	UL	1.0	UL
DILUTION FACTOR:			1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-FBC1		W-FBC2		W-MW-HN26I		W-MW-HN26S		W-MW-HN27I	
LABORATORY ID:			940285-01		940285-02		940285-05		940285-06		940285-07	
ANALYTE	CRQL	MDL										
alpha-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
beta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
delta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
gamma-BHC (LINDANE)	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
HEPTACHLOR	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
ALDRIN	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
ENDOSULFAN I	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
DIELDRIN	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
4,4'-DDE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
ENDRIN	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
ENDOSULFAN II	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
4,4'-DDD	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
ENDOSULFAN SULFATE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
4,4'-DDT	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
METHOXYCHLOR	0.50	0.10	0.50	U	0.50	U	0.50	UL	0.50	UL	0.50	UL
ENDRIN KETONE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
ENDRIN ALDEHYDE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	UL
alpha-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
gamma-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	UL
TOXAPHENE	5.0	1.67	5.0	U	5.0	U	5.0	UL	5.0	UL	5.0	UL
AROCLOR-1016	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1221	2.0	0.67	2.0	U	2.0	U	2.0	UL	2.0	UL	2.0	UL
AROCLOR-1232	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1242	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1248	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1254	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
AROCLOR-1260	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	UL
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-RB-11	
LABORATORY ID:			940275-26	
ANALYTE	CRQL	MDL		
alpha-BHC	0.050	0.010	0.050	UL
beta-BHC	0.050	0.010	0.050	UL
delta-BHC	0.050	0.010	0.050	UL
gamma-BHC (LINDANE)	0.050	0.010	0.050	UL
HEPTACHLOR	0.050	0.010	0.050	UL
ALDRIN	0.050	0.010	0.050	UL
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	UL
ENDOSULFAN I	0.050	0.010	0.050	UL
DIELDRIN	0.10	0.020	0.10	UL
4,4'-DDE	0.10	0.020	0.10	UL
ENDRIN	0.10	0.020	0.10	UL
ENDOSULFAN II	0.10	0.020	0.10	UL
4,4'-DDD	0.10	0.020	0.10	UL
ENDOSULFAN SULFATE	0.10	0.020	0.10	UL
4,4'-DDT	0.10	0.020	0.10	UL
METHOXYCHLOR	0.50	0.10	0.50	UL
ENDRIN KETONE	0.10	0.020	0.10	UL
ENDRIN ALDEHYDE	0.10	0.020	0.10	UL
alpha-CHLORDANE	0.050	0.010	0.050	UL
gamma-CHLORDANE	0.050	0.010	0.050	UL
TOXAPHENE	5.0	1.67	5.0	UL
AROCLOR-1016	1.0	0.33	1.0	UL
AROCLOR-1221	2.0	0.67	2.0	UL
AROCLOR-1232	1.0	0.33	1.0	UL
AROCLOR-1242	1.0	0.33	1.0	UL
AROCLOR-1248	1.0	0.33	1.0	UL
AROCLOR-1254	1.0	0.33	1.0	UL
AROCLOR-1260	1.0	0.33	1.0	UL
DILUTION FACTOR:			1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

CLIENT ID:			W-MW-HN-28X		W-MW-HN-29I		W-MW-HN-29S		W-MW-HN-29X		W-MW-HN-34X	
LABORATORY ID:			940275-21		940275-22		940275-23		940275-24		940275-25	
ANALYTE	CRQL	MDL										
alpha-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
beta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
delta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
gamma-BHC (LINDANE)	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
HEPTACHLOR	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
ALDRIN	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
ENDOSULFAN I	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
DIELDRIN	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
4,4'-DDE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
ENDRIN	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
ENDOSULFAN II	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
4,4'-DDD	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
ENDOSULFAN SULFATE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
4,4'-DDT	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
METHOXYCHLOR	0.50	0.10	0.50	U	0.50	U	0.50	UL	0.50	UL	0.50	U
ENDRIN KETONE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
ENDRIN ALDEHYDE	0.10	0.020	0.10	U	0.10	U	0.10	UL	0.10	UL	0.10	U
alpha-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
gamma-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	UL	0.050	UL	0.050	U
TOXAPHENE	5.0	1.67	5.0	U	5.0	U	5.0	UL	5.0	UL	5.0	U
AROCLOR-1016	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
AROCLOR-1221	2.0	0.67	2.0	U	2.0	U	2.0	UL	2.0	UL	2.0	U
AROCLOR-1232	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
AROCLOR-1242	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
AROCLOR-1248	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
AROCLOR-1254	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
AROCLOR-1260	1.0	0.33	1.0	U	1.0	U	1.0	UL	1.0	UL	1.0	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS PESTICIDES/PCB's (ug/L)

CLIENT ID:			W-MW-HN-24I		W-MW-HN-24S		W-MW-HN-24X		W-MW-HN-28I		W-MW-HN-28S	
LABORATORY ID:			940275-14		940275-15		940275-16		940275-19		940275-20	
ANALYTE	CRQL	MDL										
alpha-BHC	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
beta-BHC	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
delta-BHC	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
gamma-BHC (LINDANE)	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
HEPTACHLOR	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
ALDRIN	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
ENDOSULFAN I	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
DIELDRIN	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
4,4'-DDE	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
ENDRIN	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
ENDOSULFAN II	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.24	J
4,4'-DDD	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
ENDOSULFAN SULFATE	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
4,4'-DDT	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
METHOXYCHLOR	0.50	0.10	0.50	U	0.50	UL	0.50	UL	0.50	U	0.50	UL
ENDRIN KETONE	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
ENDRIN ALDEHYDE	0.10	0.020	0.10	U	0.10	UL	0.10	UL	0.10	U	0.10	UL
alpha-CHLORDANE	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
gamma-CHLORDANE	0.050	0.010	0.050	U	0.050	UL	0.050	UL	0.050	U	0.050	UL
TOXAPHENE	5.0	1.67	5.0	U	5.0	UL	5.0	UL	5.0	U	5.0	UL
AROCLOR-1016	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
AROCHLOR-1221	2.0	0.67	2.0	U	2.0	UL	2.0	UL	2.0	U	2.0	UL
AROCLOR-1232	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
AROCLOR-1242	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
AROCLOR-1248	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
AROCLOR-1254	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
AROCLOR-1260	1.0	0.33	1.0	U	1.0	UL	1.0	UL	1.0	U	1.0	UL
DILUTION FACTOR:			1.0		1.0		1.0				1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS PESTICIDES/PCB's (ug/L)

CLIENT ID:			W-MW-DG-16		W-MW-DG-28		W-MW-HN-23I		W-MW-HN-23S		W-MW-HN-23X	
LABORATORY ID:			940275-07		940275-10		940275-11		940275-12		940275-13	
ANALYTE	CRQL	MDL										
alpha-BHC	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
beta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
delta-BHC	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
gamma-BHC (LINDANE)	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
HEPTACHLOR	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
ALDRIN	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
HEPTACHLOR EPOXIDE	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
ENDOSULFAN I	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
DIELDRIN	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
4,4'-DDE	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
ENDRIN	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
ENDOSULFAN II	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
4,4'-DDD	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
ENDOSULFAN SULFATE	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
4,4'-DDT	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
METHOXYCHLOR	0.50	0.10	0.50	U	0.50	U	0.50	U	0.50	UL	0.50	UL
ENDRIN KETONE	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
ENDRIN ALDEHYDE	0.10	0.020	0.10	U	0.10	U	0.10	U	0.10	UL	0.10	UL
alpha-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
gamma-CHLORDANE	0.050	0.010	0.050	U	0.050	U	0.050	U	0.050	UL	0.050	UL
TOXAPHENE	5.0	1.67	5.0	U	5.0	U	5.0	U	5.0	UL	5.0	UL
AROCLOR-1016	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
AROCHLOR-1221	2.0	0.67	2.0	U	2.0	U	2.0	U	2.0	UL	2.0	UL
AROCLOR-1232	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
AROCLOR-1242	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
AROCLOR-1248	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
AROCLOR-1254	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
AROCLOR-1260	1.0	0.33	1.0	U	1.0	U	1.0	U	1.0	UL	1.0	UL
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN27S		W-MW-HN34S		W-RB12	
LABORATORY ID:			940285-08		940285-09		940285-12	
ANALYTE	CRQL	MDL						
2,4-DINITROPHENOL	25	2.5	25	U	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U	25	U
DIBENZOFURAN	10	1	10	U	10	U	10	U
2,4-DINITROTOLUENE	10	1	10	U	10	U	10	U
DIETHYL PHTHALATE	10	1	10	U	10	U	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U
FLUORENE	10	1	10	U	10	U	10	U
4-NITROANILINE	25	2.5	25	U	25	U	25	U
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U	10	U	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U
HEXACHLOROBENZENE	10	1	10	U	10	U	10	U
PENTACHLOROPHENOL	25	2.5	25	U	25	U	25	U
PHENANTHRENE	10	1	10	U	10	U	10	U
ANTHRACENE	10	1	10	U	10	U	10	U
DI-n-BUTYLPHTHALATE	10	1	10	U	1	J	10	U
FLUORANTHENE	10	1	10	U	10	U	10	U
CARBAZOLE	10	1	10	UJ	10	UJ	10	UJ
PYRENE	10	1	10	U	10	U	10	U
BUTYLBENZYLPHTHALATE	10	1	10	U	10	U	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	UJ	10	UJ	10	UJ
BENZO(a)ANTHRACENE	10	1	10	U	10	U	10	U
CHRYSENE	10	1	10	U	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	1	B	2	B	10	U
DI-n-OCTYLPHTHALATE	10	1	10	U	10	U	10	U
BENZO(b)FLUORANTHENE	10	1	10	U	10	U	10	U
BENZO(k)FLUORANTHENE	10	1	10	U	10	U	10	U
BENZO(a)PYRENE	10	1	10	U	10	U	10	U
INDENO(1,2,3-cd)PYRENE	10	1	10	U	10	U	10	U
DIBENZO(a,h)ANTHRACENE	10	1	10	U	10	U	10	U
BENZO(g,h,i)PERYLENE	10	1	10	U	10	U	10	U
DILUTION FACTOR:			1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN27S		W-MW-HN34S		W-RB12	
LABORATORY ID:			940285-08		940285-09		940285-12	
ANALYTE	CRQL	MDL						
PHENOL	10	1	10	U	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U	10	U	10	U
2-CHLOROPHENOL	10	1	10	U	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	U	10	U	10	U
1,4-DICHLOROBENZENE	10	1	10	U	10	U	10	U
1,2-DICHLOROBENZENE	10	1	10	U	10	U	10	U
2-METHYLPHENOL	10	1	10	U	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U	10	U	10	U
4-METHYLPHENOL	10	1	10	U	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U	10	U	10	U
HEXACHLOROETHANE	10	1	10	U	10	U	10	U
NITROBENZENE	10	1	10	U	10	U	10	U
ISOPHORONE	10	1	10	U	10	U	10	U
2-NITROPHENOL	10	1	10	U	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U	10	U	10	U
2,4-DICHLOROPHENOL	10	1	10	U	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U	10	U	10	U
NAPHTHALENE	10	1	10	U	10	U	10	U
4-CHLOROANILINE	10	1	10	U	10	U	10	U
HEXACHLOROBUTADIENE	10	1	10	U	10	U	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	U	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	U	10	U	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	U	10	U	10	U
2-NITROANILINE	25	2.5	25	U	25	U	25	U
DIMETHYLPHTHALATE	10	1	10	U	10	U	10	U
ACENAPHTHYLENE	10	1	10	U	10	U	10	U
2,6-DINITROTOLUENE	10	1	10	U	10	U	10	U
3-NITROANILINE	25	2.5	25	U	25	U	25	U
ACENAPHTHENE	10	1	10	U	10	U	10	U

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TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-FBC1		W-FBC2		W-MW-HN26I		W-MW-HN26S		W-MW-HN27I	
LABORATORY ID:			940285-01		940285-02		940285-05		940285-06		940285-07	
ANALYTE	CRQL	MDL										
2,4-DINITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
DIBENZOFURAN	10	1	10	U	10	U	10	U	10	U	10	UL
2,4-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	UL
DIETHYL PHTHALATE	10	1	10	U	10	U	10	U	10	U	10	UL
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	UL
FLUORENE	10	1	10	U	10	U	10	U	10	U	10	UL
4-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	UL
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U	10	U	10	U	10	U	10	UL
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	UL
HEXACHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
PENTACHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
PHENANTHRENE	10	1	10	U	10	U	10	U	10	U	10	UL
ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	UL
DI-n-BUTYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	1	J
FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	UL
CARBAZOLE	10	1	10	UJ	10	UJ	10	UJ	10	UJ	10	UL
PYRENE	10	1	10	U	10	U	10	U	10	U	10	UL
BUTYLBENZYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	UL
3,3'-DICHLOROBENZIDINE	10	1	10	UJ	10	UJ	10	UJ	10	UJ	10	UL
BENZO(a)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	UL
CHRYSENE	10	1	10	U	10	U	10	U	10	U	10	UL
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	10	U	10	U	10	U	1	B	2	B
DI-n-OCTYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	UL
BENZO(b)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	UL
BENZO(k)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	UL
BENZO(a)PYRENE	10	1	10	U	10	U	10	U	10	U	10	UL
INDENO(1,2,3-cd)PYRENE	10	1	10	U	10	U	10	U	10	U	10	UL
DIBENZO(a,h)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	UL
BENZO(g,h,i)PERYLENE	10	1	10	U	10	U	10	U	10	U	10	UL
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

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CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-FBC1		W-FBC2		W-MW-HN26I		W-MW-HN26S		W-MW-HN27I	
LABORATORY ID:			940285-01		940285-02		940285-05		940285-06		940285-07	
ANALYTE	CRQL	MDL										
PHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U	10	U	10	U	10	U	10	UL
2-CHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
1,4-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
1,2-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
2-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U	10	U	10	U	10	U	10	UL
4-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U	10	U	10	U	10	U	10	UL
HEXACHLOROETHANE	10	1	10	U	10	U	10	U	10	U	10	UL
NITROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
ISOPHORONE	10	1	10	U	10	U	10	U	10	U	10	UL
2-NITROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U	10	U	10	U	10	U	10	UL
2,4-DICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	UL
NAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	UL
4-CHLOROANILINE	10	1	10	U	10	U	10	U	10	U	10	UL
HEXACHLOROBUTADIENE	10	1	10	U	10	U	10	U	10	U	10	UL
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	UL
HEXACHLOROCYCLOPENTADIENE	10	1	10	U	10	U	10	U	10	U	10	UL
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	UL
2-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	UL
DIMETHYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	UL
ACENAPHTHYLENE	10	1	10	U	10	U	10	U	10	U	10	UL
2,6-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	UL
3-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	UL
ACENAPHTHENE	10	1	10	U	10	U	10	U	10	U	10	UL

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TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-24I		W-MW-HN-24S		W-MW-HN-24X		W-MW-HN-25I		W-MW-HN-25S	
LABORATORY ID:			940275-14		940275-15		940275-16		940275-17		940275-18	
ANALYTE	CRQL	MDL										
2,4-DINITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
DIBENZOFURAN	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	U
DIETHYL PHTHALATE	10	1	10	U	10	U	1	J	10	U	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	U
FLUORENE	10	1	10	U	10	U	10	U	10	U	10	U
4-NITROANILINE	25	2.5	25	UJ	25	UJ	25	UJ	25	U	25	U
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U	10	U	10	U	10	U	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
PENTACHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
PHENANTHRENE	10	1	10	U	10	U	10	U	10	U	10	U
ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
DI-n-BUTYLPHTHALATE	10	1	10	U	10	U	10	U	2	J	2	J
FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
CARBAZOLE	10	1	10	U	10	U	10	UJ	10	UJ	10	U
PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
BUTYLBENZYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	U	10	U	10	U	10	UJ	10	U
BENZO(a)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
CHRYSENE	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	1	B	2	B	1	B	2	B	10	U
DI-n-OCTYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(b)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(k)FLUORANTHENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(a)PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
INDENO(1,2,3-cd)PYRENE	10	1	10	U	10	U	10	U	10	U	10	U
DIBENZO(a,h)ANTHRACENE	10	1	10	U	10	U	10	U	10	U	10	U
BENZO(g,h,i)PERYLENE	10	1	10	U	10	U	10	U	10	U	10	U
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

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CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-24I		W-MW-HN-24S		W-MW-HN-24		W-MW-HN-25I		W-MW-HN-25S	
LABORATORY ID:			940275-14		940275-15		940275-16		940275-17		940275-18	
ANALYTE	CRQL	MDL										
PHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U	10	U	10	U	10	U	10	U
2-CHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
1,4-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
1,2-DICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U	10	U	10	U	10	U	10	U
4-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROETHANE	10	1	10	U	10	U	10	U	10	U	10	U
NITROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
ISOPHORONE	10	1	10	U	10	U	10	U	10	U	10	U
2-NITROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U	10	U	10	U	10	U	10	U
NAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
4-CHLOROANILINE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROBUTADIENE	10	1	10	U	10	U	10	U	10	U	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	U	10	U	10	U	10	U	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	U	10	U	10	U	10	U	10	U
2-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	U
DIMETHYLPHTHALATE	10	1	10	U	10	U	10	U	10	U	10	U
ACENAPHTHYLENE	10	1	10	U	10	U	10	U	10	U	10	U
2,6-DINITROTOLUENE	10	1	10	U	10	U	10	U	10	U	10	U
3-NITROANILINE	25	2.5	25	U	25	U	25	U	25	U	25	U
ACENAPHTHENE	10	1	10	U	10	U	10	U	10	U	10	U

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TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-DG-16		W-MW-DG-28		W-MW-HN-23I		W-MW-HN-23S		W-MW-HN-23X	
LABORATORY ID:			940275-07		940275-10		940275-11		940275-12		940275-13	
ANALYTE	CRQL	MDL										
2,4-DINITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
DIBENZOFURAN	10	1	10	UL	10	U	10	U	10	U	10	U
2,4-DINITROTOLUENE	10	1	10	UL	10	U	10	U	10	U	10	U
DIETHYL PHTHALATE	10	1	10	UL	10	U	10	U	10	U	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	UL	10	U	10	U	10	U	10	U
FLUORENE	10	1	10	UL	10	U	10	U	10	U	10	U
4-NITROANILINE	25	2.5	25	UL	25	U	25	U	25	U	25	U
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	UL	10	U	10	U	10	U	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	UL	10	U	10	U	10	U	10	U
HEXACHLOROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
PENTACHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
PHENANTHRENE	10	1	10	UL	10	U	10	U	10	U	10	U
ANTHRACENE	10	1	10	UL	10	U	10	U	10	U	10	U
DI-n-BUTYLPHTHALATE	10	1	10	UL	10	U	10	U	10	U	10	U
FLUORANTHENE	10	1	10	UL	10	U	10	U	10	U	10	U
CARBAZOLE	10	1	10	UL	10	U	10	U	10	U	10	U
PYRENE	10	1	10	UL	10	U	10	U	10	U	10	U
BUTYLBENZYLPHTHALATE	10	1	10	UL	10	U	10	U	10	U	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	UL	10	U	10	U	10	U	10	U
BENZO(a)ANTHRACENE	10	1	10	UL	10	U	10	U	10	U	10	U
CHRYSENE	10	1	10	UL	10	U	10	U	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	1	B	1	B	2	B	2	B	1	B
DI-n-OCTYLPHTHALATE	10	1	10	UL	10	U	10	U	10	U	10	UJ
BENZO(b)FLUORANTHENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
BENZO(k)FLUORANTHENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
BENZO(a)PYRENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
INDENO(1,2,3-cd)PYRENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
DIBENZO(a,h)ANTHRACENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
BENZO(g,h,i)PERYLENE	10	1	10	UL	10	U	10	U	10	U	10	UJ
DILUTION FACTOR:			1.0		1.0		1.0		1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-DG-16		W-MW-DG-28		W-MW-HN-23I		W-MW-HN-23S		W-MW-HN-23X	
LABORATORY ID:			940275-07		940275-10		940275-11		940275-12		940275-13	
ANALYTE	CRQL	MDL										
PHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	UL	10	U	10	U	10	U	10	U
2-CHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
1,4-DICHLOROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
1,2-DICHLOROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
2-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	UL	10	U	10	U	10	U	10	U
4-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	UL	10	U	10	U	10	U	10	U
HEXACHLOROETHANE	10	1	10	UL	10	U	10	U	10	U	10	U
NITROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
ISOPHORONE	10	1	10	UL	10	U	10	U	10	U	10	U
2-NITROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	UL	10	U	10	U	10	U	10	U
2,4-DICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	UL	10	U	10	U	10	U	10	U
NAPHTHALENE	10	1	10	UL	10	U	10	U	10	U	10	U
4-CHLOROANILINE	10	1	10	UL	10	U	10	U	10	U	10	U
HEXACHLOROBUTADIENE	10	1	10	UL	10	U	10	U	10	U	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	UL	10	U	10	U	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	UL	10	U	10	U	10	U	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U	10	U	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U	25	U	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	UL	10	U	10	U	10	U	10	U
2-NITROANILINE	25	2.5	25	UL	25	U	25	U	25	U	25	U
DIMETHYLPHTHALATE	10	1	10	UL	10	U	10	U	10	U	10	U
ACENAPHTHYLENE	10	1	10	UL	10	U	10	U	10	U	10	U
2,6-DINITROTOLUENE	10	1	10	UL	10	U	10	U	10	U	10	U
3-NITROANILINE	25	2.5	25	UL	25	U	25	U	25	U	25	U
ACENAPHTHENE	10	1	10	UL	10	U	10	U	10	U	10	U

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-28I		W-MW-HN-28S	
LABORATORY ID:			940275-19		940275-20	
ANALYTE	CRQL	MDL				
2,4-DINITROPHENOL	25	2.5	25	U	25	U
4-NITROPHENOL	25	2.5	25	U	25	U
DIBENZOFURAN	10	1	10	U	10	U
2,4-DINITROTOLUENE	10	1	10	U	10	U
DIETHYL PHTHALATE	10	1	10	U	10	U
4-CHLOROPHENYL-PHENYL ETHER	10	1	10	U	10	U
FLUORENE	10	1	10	U	10	U
4-NITROANILINE	25	2.5	25	UJ	25	UJ
4,6-DINITRO-2-METHYLPHENOL	25	2.5	25	U	25	U
N-NITROSODIPHENYLAMINE	10	1	10	U	10	U
4-BROMOPHENYL-PHENYL ETHER	10	1	10	U	10	U
HEXACHLOROBENZENE	10	1	10	U	10	U
PENTACHLOROPHENOL	25	2.5	25	U	25	U
PHENANTHRENE	10	1	10	U	10	U
ANTHRACENE	10	1	10	U	10	U
DI-n-BUTYLPHTHALATE	10	1	10	U	1	J
FLUORANTHENE	10	1	10	U	10	U
CARBAZOLE	10	1	10	U	10	U
PYRENE	10	1	10	U	10	U
BUTYLBENZYLPHTHALATE	10	1	10	U	10	U
3,3'-DICHLOROBENZIDINE	10	1	10	U	10	U
BENZO(a)ANTHRACENE	10	1	10	U	10	U
CHRYSENE	10	1	10	U	10	U
BIS(2-ETHYLHEXYL)PHTHALATE	10	1	10	U	10	U
DI-n-OCTYLPHTHALATE	10	1	10	U	10	U
BENZO(b)FLUORANTHENE	10	1	10	U	10	U
BENZO(k)FLUORANTHENE	10	1	10	U	10	U
BENZO(a)PYRENE	10	1	10	U	10	U
INDENO(1,2,3-cd)PYRENE	10	1	10	U	10	U
DIBENZO(a,h)ANTHRACENE	10	1	10	U	10	U
BENZO(g,h,i)PERYLENE	10	1	10	U	10	U
DILUTION FACTOR:			1.0		1.0	

CTO 159, NAWC, WARMINSTER, PENNSYLVANIA
CEIMIC CORPORATION

TCL AQUEOUS SEMI-VOLATILE ORGANICS (ug/L)

CLIENT ID:			W-MW-HN-28I		W-MW-HN-28S	
LABORATORY ID:			940275-19		940275-20	
ANALYTE	CRQL	MDL				
PHENOL	10	1	10	U	10	U
BIS(2-CHLOROETHYL)ETHER	10	1	10	U	10	U
2-CHLOROPHENOL	10	1	10	U	10	U
1,3-DICHLOROBENZENE	10	1	10	U	10	U
1,4-DICHLOROBENZENE	10	1	10	U	10	U
1,2-DICHLOROBENZENE	10	1	10	U	10	U
2-METHYLPHENOL	10	1	10	U	10	U
2,2'-OXYBIS(1-CHLOROPROPANE)	10	1	10	U	10	U
4-METHYLPHENOL	10	1	10	U	10	U
N-NITROSO-DI-n-PROPYLAMINE	10	1	10	U	10	U
HEXACHLOROETHANE	10	1	10	U	10	U
NITROBENZENE	10	1	10	U	10	U
ISOPHORONE	10	1	10	U	10	U
2-NITROPHENOL	10	1	10	U	10	U
2,4-DIMETHYLPHENOL	10	1	10	U	10	U
BIS(2-CHLOROETHOXY)METHANE	10	1	10	U	10	U
2,4-DICHLOROPHENOL	10	1	10	U	10	U
1,2,4-TRICHLOROBENZENE	10	1	10	U	10	U
NAPHTHALENE	10	1	10	U	10	U
4-CHLOROANILINE	10	1	10	U	10	U
HEXACHLOROBUTADIENE	10	1	10	U	10	U
4-CHLORO-3-METHYLPHENOL	10	1	10	U	10	U
2-METHYLNAPHTHALENE	10	1	10	U	10	U
HEXACHLOROCYCLOPENTADIENE	10	1	10	U	10	U
2,4,6-TRICHLOROPHENOL	10	1	10	U	10	U
2,4,5-TRICHLOROPHENOL	25	2.5	25	U	25	U
2-CHLORONAPHTHALENE	10	1	10	U	10	U
2-NITROANILINE	25	2.5	25	U	25	U
DIMETHYLPHTHALATE	10	1	10	U	10	U
ACENAPHTHYLENE	10	1	10	U	10	U
2,6-DINITROTOLUENE	10	1	10	U	10	U
3-NITROANILINE	25	2.5	25	U	25	U
ACENAPHTHENE	10	1	10	U	10	U

APPENDIX F

RISK CALCULATIONS

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: NAVY CLEAN - CTO 159 - NAWC WARMINSTER	JOB NUMBER: 1412
SUBJECT: DETERMINATION of REPRESENTATIVE CONCENTRATIONS	
BASED ON: R.O. GILBERT, 1987	DRAWING NUMBER:
BY: NORMAN STRAUB / CHECKED BY: KMS	APPROVED BY: / DATE: 07/29/94

PURPOSE: CALCULATE CHEMICAL-SPECIFIC REPRESENTATIVE CONCENTRATIONS BASED ON THE 95% UCL FOR A GIVEN DATA SET.

RELEVANT EQUATIONS:

- STANDARD DEVIATION

$$S = \sqrt{\frac{\sum x_i^2 - \frac{1}{n}\sum (x_i)^2}{n-1}}$$

WHERE: S = Standard Deviation
X_i = INDIVIDUAL DATUM
n = Sample population

- 95% UCL of NORMALLY DISTRIBUTED DATA

$$UCL = \bar{X} + \frac{t_{1-\alpha} S}{\sqrt{n}}$$

WHERE: UCL = UPPER CONFIDENCE LIMIT ON MEAN
$\bar{X}$ = MEAN OF DATA SET = $\sum x_i / n$
$t_{1-\alpha}$ = ONE-SIDED t DISTRIBUTION FACTOR FROM TABLE A2 (GILBERT, 1987)
S = STANDARD DEVIATION
n = Sample population

CLIENT NAVY CLEAN - CTO 159 - NAWC WARMINSTER	JOB NUMBER 1412
SUBJECT SHAPIRO-WILK W-TEST FOR GOODNESS OF FIT	
BASED ON R.O. GILBERT, 1987	DRAWING NUMBER
BY NORMAN STRAUB / CHECKED BY AMS	APPROVED BY / DATE 07/29/94

RELEVANT EQUATIONS (CON'T):

- 95% UCL of LOG-NORMALLY DISTRIBUTED DATA

$$UCL = e^{\left(\bar{X} + 0.5S^2 + SH/\sqrt{n-1}\right)}$$

WHERE:
- UCL = UPPER CONFIDENCE LIMIT
- $\bar{X}$ = MEAN OF LOG-TRANSFORMED DATA
- S = STANDARD DEVIATION OF TRANSFORMED DATA
- H = H-STATISTIC FROM TABLE A12 (GILBERT, 1987)
- n = Sample POPULATION.

Sample CALCULATION:

FOR ZINC (TOTAL) IN AREA C DOWNGRADIENT WELLS (BG-5, MW01,* MW02,* DG-4, DG-5, DG-6, DG-14, DG-15, DG-16, DG-22, DG-24, DG-28, HN23-S,* HN23-I, HN23-X, HN24-S, HN24-I,* HN24-X,* HN25-S, HN25-I, HN27-S, HN27-I, HN28-S, HN28-I, HN28-X,* HN29-S, HN29-I,* HN29-X, HN34-S, HN34-X*)

X_1 = 1.5 mg/L
X_2 = 8.7
X_3 = 9.8
X_4 = 11.4
X_5 = 25
X_6 = 29.2
X_7 = 46.2
X_8 = 47.8
X_9 = 48.8
X_{10} = 71.3
X_{11} = 225

* FIELD DUPLICATE SAMPLES INCLUDE -

1. MW01 and MW02
2. HN24-I " HN24-X
3. HN28-X " HN29-I
4. HN23-S " HN34-X

n = 11 samples

CLIENT NAVY CLEAN - CTO 159 - NAWC WARMINSTER	JOB NUMBER 1412
SUBJECT DETERMINATION of REPRESENTATIVE CONCENTRATIONS	
BASED ON R.O. GILBERT, 1987	DRAWING NUMBER
BY NORMAN STRAUB / CHECKED BY NMS	APPROVED BY / DATE 07/29/94

SAMPLE CALCULATION (CON'T.):

- STANDARD DEVIATION

x_i	x_i^2	$\ln x_i$	$(\ln x_i)^2$
1.5	2.25	0.405	0.164
8.7	75.69	2.16	4.68
9.8	96.04	2.28	5.21
11.4	129.96	2.43	5.92
25	625	3.21	10.4
29.2	852.64	3.37	11.4
46.2	2134.44	3.83	14.7
47.8	2284.84	3.86	15.0
48.8	2381.44	3.89	15.1
71.3	5083.69	4.27	18.2
225	50,625	5.42	29.3
$\Sigma =$ 524.7	= 64,290.99	= 35.15	= 130.0

NORMAL

$$S = \sqrt{\frac{64{,}290.99 - \left(\frac{1}{11}\right)(524.7)^2}{11-1}} = 62.7$$

LOG NORMAL

$$S = \sqrt{\frac{130.0 - \left(\frac{1}{11}\right)(35.15)^2}{11-1}} = 1.33$$

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: NAVY CLEAN - CTO 159 - NAWC WARMINSTER	JOB NUMBER: 1412
SUBJECT: DETERMINATION of REPRESENTATIVE CONCENTRATIONS	
BASED ON: R.O. GILBERT, 1987	DRAWING NUMBER:
BY: NORMAN STRAUB / CHECKED BY: MS	APPROVED BY: / DATE: 07/29/94

- 95% UCL of NORMALLY DISTRIBUTED DATA

$$UCL = \left(\frac{524.7}{11}\right) + \frac{(1.812)(62.7)}{\sqrt{11}} \quad , \quad t_{0.95} = 1.812 \text{ for 10 DEGREES of FREEDOM}$$

$$\boxed{UCL = 81.9 \ \mu g/L}$$

- 95% UCL of LOG-NORMALLY DISTRIBUTED DATA

$$UCL = e^{\left(\frac{35.15}{11} + (0.5)(1.33)^2 + \frac{(1.33)(3.686^*)}{\sqrt{11-1}}\right)}$$

$$\boxed{UCL = 279 \ \mu g/L}$$

* H STATISTIC VALUE INTERPOLATED FROM THE FOLLOWING DATA:

S	n = 10	n = 12
1.25	3.639	3.389
1.50	4.207	3.896

FOR S = 1.33 and n = 11:

$$H_{10}(S=1.33) = 3.639 + \left[\frac{(1.33-1.25)}{(1.5-1.25)}\right]\left[4.207-3.639\right] = 3.82$$

$$H_{12}(S=1.33) = 3.389 + \left[\frac{(1.33-1.25)}{(1.5-1.25)}\right]\left[3.896-3.389\right] = 3.551$$

$$H_{11}(S=1.33) = 3.551 + \left[\frac{(11-10)}{(12-10)}(3.821-3.551)\right] = 3.686$$

FROM THE RESULTS of the W-TEST, ZINC (TOTAL) IS KNOWN TO HAVE NORMAL DATA DISTRIBUTION CHARACTERISTICS. THEREFORE, THE UCL OF THE ARITHMETIC MEAN (81.9 µg/L) IS RETAINED AS THE REPRESENTATIVE CONCENTRATION FOR THIS ANALYTE.

REFERENCE:

GILBERT, R.O. 1987. STATISTICAL METHODS FOR ENVIRONMENTAL POLLUTION MONITORING. VAN NOSTRAND REINHOLD, NEW YORK.

Table A2 Quantiles of the t Distribution (Values of t Such That $100p\%$ of the Distribution Is Less Than t_p)

Degrees of Freedom	$t_{0.60}$	$t_{0.70}$	$t_{0.80}$	$t_{0.90}$	$t_{0.95}$	$t_{0.975}$	$t_{0.990}$	$t_{0.995}$
1	.325	.727	1.376	3.078	6.314	12.706	31.821	63.657
2	.289	.617	1.061	1.886	2.920	4.303	6.965	9.925
3	.277	.584	.978	1.638	2.353	3.182	4.541	5.841
4	.271	.569	.941	1.533	2.132	2.776	3.747	4.604
5	.267	.559	.920	1.476	2.015	2.571	3.365	4.032
6	.265	.553	.906	1.440	1.943	2.447	3.143	3.707
7	.263	.549	.896	1.415	1.895	2.365	2.998	3.499
8	.262	.546	.889	1.397	1.860	2.306	2.896	3.355
9	.261	.543	.883	1.383	1.833	2.262	2.821	3.250
10	.260	.542	.879	1.372	1.812	2.228	2.764	3.169
11	.260	.540	.876	1.363	1.796	2.201	2.718	3.106
12	.259	.539	.873	1.356	1.782	2.179	2.681	3.055
13	.259	.538	.870	1.350	1.771	2.160	2.650	3.012
14	.258	.537	.868	1.345	1.761	2.145	2.624	2.977
15	.258	.536	.866	1.341	1.753	2.131	2.602	2.947
16	.258	.535	.865	1.337	1.746	2.120	2.583	2.921
17	.257	.534	.863	1.333	1.740	2.110	2.567	2.898
18	.257	.534	.862	1.330	1.734	2.101	2.552	2.878
19	.257	.533	.861	1.328	1.729	2.093	2.539	2.861
20	.257	.533	.860	1.325	1.725	2.086	2.528	2.845
21	.257	.532	.859	1.323	1.721	2.080	2.518	2.831
22	.256	.532	.858	1.321	1.717	2.074	2.508	2.819
23	.256	.532	.858	1.319	1.714	2.069	2.500	2.807
24	.256	.531	.857	1.318	1.711	2.064	2.492	2.797
25	.256	.531	.856	1.316	1.708	2.060	2.485	2.787
26	.256	.531	.856	1.315	1.706	2.056	2.479	2.779
27	.256	.531	.855	1.314	1.703	2.052	2.473	2.771
28	.256	.530	.855	1.313	1.701	2.048	2.467	2.763
29	.256	.530	.854	1.311	1.699	2.045	2.462	2.756
30	.256	.530	.854	1.310	1.697	2.042	2.457	2.750
40	.255	.529	.851	1.303	1.684	2.021	2.423	2.704
60	.254	.527	.848	1.296	1.671	2.000	2.390	2.660
120	.254	.526	.845	1.289	1.658	1.980	2.358	2.617
∞	.253	.524	.842	1.282	1.645	1.960	2.326	2.576

Source: From Fisher and Yates, 1974. Used by permission.
This table is first used in Section 4.4.2.

% Confidence Limit

51	101
1.301	1.295
1.324	1.314
1.354	1.339
1.390	1.371
1.434	1.409
1.485	1.454
1.541	1.504
1.604	1.560
1.672	1.621
1.745	1.686
1.946	1.866
2.166	2.066
2.402	2.279
2.648	2.503
3.163	2.974
3.697	3.463
4.242	3.965
4.796	4.474
5.354	4.989
5.916	5.508
7.046	6.555
8.186	7.607
9.329	8.665
10.48	9.725
11.62	10.79

Table A12 Values of $H_{1-\alpha} = H_{0.95}$ for Computing a One-Sided Upper 95% Confidence Limit on a Lognormal Mean

	n									
s_y	3	5	7	10	12	15	21	31	51	101
0.10	2.750	2.035	1.886	1.802	1.775	1.749	1.722	1.701	1.684	1.670
0.20	3.295	2.198	1.992	1.881	1.843	1.809	1.771	1.742	1.718	1.697
0.30	4.109	2.402	2.125	1.977	1.927	1.882	1.833	1.793	1.761	1.733
0.40	5.220	2.651	2.282	2.089	2.026	1.968	1.905	1.856	1.813	1.777
0.50	6.495	2.947	2.465	2.220	2.141	2.068	1.989	1.928	1.876	1.830
0.60	7.807	3.287	2.673	2.368	2.271	2.181	2.085	2.010	1.946	1.891
0.70	9.120	3.662	2.904	2.532	2.414	2.306	2.191	2.102	2.025	1.960
0.80	10.43	4.062	3.155	2.710	2.570	2.443	2.307	2.202	2.112	2.035
0.90	11.74	4.478	3.420	2.902	2.738	2.589	2.432	2.310	2.206	2.117
1.00	13.05	4.905	3.698	3.103	2.915	2.744	2.564	2.423	2.306	2.205
1.25	16.33	6.001	4.426	3.639	3.389	3.163	2.923	2.737	2.580	2.447
1.50	19.60	7.120	5.184	4.207	3.896	3.612	3.311	3.077	2.881	2.713
1.75	22.87	8.250	5.960	4.795	4.422	4.081	3.719	3.437	3.200	2.997
2.00	26.14	9.387	6.747	5.396	4.962	4.564	4.141	3.812	3.533	3.295
2.50	32.69	11.67	8.339	6.621	6.067	5.557	5.013	4.588	4.228	3.920
3.00	39.23	13.97	9.945	7.864	7.191	6.570	5.907	5.388	4.947	4.569
3.50	45.77	16.27	11.56	9.118	8.326	7.596	6.815	6.201	5.681	5.233
4.00	52.31	18.58	13.18	10.38	9.469	8.630	7.731	7.024	6.424	5.908
4.50	58.85	20.88	14.80	11.64	10.62	9.669	8.652	7.854	7.174	6.590
5.00	65.39	23.19	16.43	12.91	11.77	10.71	9.579	8.688	7.929	7.277
6.00	78.47	27.81	19.68	15.45	14.08	12.81	11.44	10.36	9.449	8.661
7.00	91.55	32.43	22.94	18.00	16.39	14.90	13.31	12.05	10.98	10.05
8.00	104.6	37.06	26.20	20.55	18.71	17.01	15.18	13.74	12.51	11.45
9.00	117.7	41.68	29.46	23.10	21.03	19.11	17.05	15.43	14.05	12.85
10.00	130.8	46.31	32.73	25.66	23.35	21.22	18.93	17.13	15.59	14.26

Source: After Land, 1975.
This table is used in Section 13.2.

Confidence Limit on

51	101
.278	-1.279
.275	-1.280
.280	-1.287
.289	-1.301
.304	-1.319
.324	-1.342
.349	-1.370
.377	-1.403
.409	-1.439
.445	-1.478
.547	-1.589
.063	-1.716
.790	-1.855
.928	-2.003
.223	-2.321
.536	-2.657
.864	-3.007
.200	-3.366
.542	-3.731
.889	-4.100
.594	-4.849
307	-5.607
.026	-6.370
748	-7.136
474	-7.906

Table A13 Values of $H_{\alpha} = H_{0.05}$ for Computing a One-Sided Lower 5% Confidence Limit on a Lognormal Mean

	n									
s_y	3	5	7	10	12	15	21	31	51	101
0.10	-2.130	-1.806	-1.731	-1.690	-1.677	-1.666	-1.655	-1.648	-1.644	-1.642
0.20	-1.949	-1.729	-1.678	-1.653	-1.646	-1.640	-1.636	-1.636	-1.637	-1.641
0.30	-1.816	-1.669	-1.639	-1.627	-1.625	-1.625	-1.627	-1.632	-1.638	-1.648
0.40	-1.717	-1.625	-1.611	-1.611	-1.613	-1.617	-1.625	-1.635	-1.647	-1.662
0.50	-1.644	-1.594	-1.594	-1.603	-1.609	-1.618	-1.631	-1.646	-1.663	-1.683
0.60	-1.589	-1.573	-1.584	-1.602	-1.612	-1.625	-1.643	-1.662	-1.685	-1.711
0.70	-1.549	-1.560	-1.582	-1.608	-1.622	-1.638	-1.661	-1.686	-1.713	-1.744
0.80	-1.521	-1.555	-1.586	-1.620	-1.636	-1.656	-1.685	-1.714	-1.747	-1.783
0.90	-1.502	-1.556	-1.595	-1.637	-1.656	-1.680	-1.713	-1.747	-1.785	-1.826
1.00	-1.490	-1.562	-1.610	-1.658	-1.681	-1.707	-1.745	-1.784	-1.827	-1.874
1.25	-1.486	-1.596	-1.662	-1.727	-1.758	-1.793	-1.842	-1.893	-1.949	-2.012
1.50	-1.508	-1.650	-1.733	-1.814	-1.853	-1.896	-1.958	-2.020	-2.091	-2.169
1.75	-1.547	-1.719	-1.819	-1.916	-1.962	-2.015	-2.088	-2.164	-2.247	-2.341
2.00	-1.598	-1.799	-1.917	-2.029	-2.083	-2.144	-2.230	-2.318	-2.416	-2.526
2.50	-1.727	-1.986	-2.138	-2.283	-2.351	-2.430	-2.540	-2.654	-2.780	-2.921
3.00	-1.880	-2.199	-2.384	-2.560	-2.644	-2.740	-2.874	-3.014	-3.169	-3.342
3.50	-2.051	-2.429	-2.647	-2.855	-2.953	-3.067	-3.226	-3.391	-3.574	-3.780
4.00	-2.237	-2.672	-2.922	-3.161	-3.275	-3.406	-3.589	-3.779	-3.990	-4.228
4.50	-2.434	-2.924	-3.206	-3.476	-3.605	-3.753	-3.960	-4.176	-4.416	-4.685
5.00	-2.638	-3.183	-3.497	-3.798	-3.941	-4.107	-4.338	-4.579	-4.847	-5.148
6.00	-3.062	-3.715	-4.092	-4.455	-4.627	-4.827	-5.106	-5.397	-5.721	-6.086
7.00	-3.499	-4.260	-4.699	-5.123	-5.325	-5.559	-5.886	-6.227	-6.608	-7.036
8.00	-3.945	-4.812	-5.315	-5.800	-6.031	-6.300	-6.674	-7.066	-7.507	-7.992
9.00	-4.397	-5.371	-5.936	-6.482	-6.742	-7.045	-7.468	-7.909	-8.401	-8.953
10.00	-4.852	-5.933	-6.560	-7.168	-7.458	-7.794	-8.264	-8.755	-9.302	-9.918

Source: After Land, 1975.

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: NAVY CLEAN - CTO 159 - NAWC WARMINSTER	JOB NUMBER: 1412
SUBJECT: SHAPIRO-WILK W-TEST FOR GOODNESS OF FIT	
BASED ON: R.O. GILBERT, 1987	DRAWING NUMBER:
BY: NORMAN STRAUB / CHECKED BY: AAS	APPROVED BY: / DATE: 07/29/94

PURPOSE: DETERMINE DETERMINE DATA DISTRIBUTION CHARACTERISTICS FOR A GIVEN DATA SET.

DESCRIPTION: THE W-TEST PROVIDES A METHOD FOR TESTING A DATA SET TO DETERMINE IF IT HAS BEEN DRAWN FROM AN UNDERLYING NORMAL DISTRIBUTION. ALSO, BY EVALUATING THE LOGARITHMS OF THE SAME DATA SET, THE W-TEST CAN ALSO IDENTIFY LOG-NORMALLY DISTRIBUTED DATA.

THE TEST NUMERICALLY TESTS A NULL HYPOTHESIS THAT THE DATA IS NORMALLY/LOG-NORMALLY DISTRIBUTED. THE NULL HYPOTHESIS IS REJECTED IF A NEGATIVE TEST RESULT IS OBTAINED.

ASSUMPTIONS: THE FOLLOWING DATA SET WILL BE EVALUATED.

ZINC (TOTAL) - AREA C DOWNGRADIENT WELLS (BG-5, MW-02,* MW-01*, DG-4, DG-5, DG-6, DG-14, DG-15, DG-16, DG-22, DG-24, DG-28, HN23-S*, HN23-I, HN23-X, HN24-S, HN24-I*, HN24-X*, HN25-S, HN25-I, HN27-S, HN27-I, HN28-S, HN28-I, HN28-X*, HN29-S, HN29-I*, HN29-X, HN34-S, HN34-X*)

$X_1 = 1.5$ mg/L
$X_2 = 8.7$
$X_3 = 9.8$
$X_4 = 11.4$
$X_5 = 25$
$X_6 = 29.2$
$X_7 = 46.2$
$X_8 = 47.8$
$X_9 = 48.8$
$X_{10} = 71.3$
$X_{11} = 225$

* NOTE: FIELD DUPLICATES INCLUDE -

1. MW01 and MW02
2. HN24-I " HN24-X
3. HN28-X " HN29-I
4. HN23-S " HN34-X

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NAVY CLEAN - CTO 159 - NAWC WARMINSTER	JOB NUMBER 1412
SUBJECT SHAPIRO-WILK W-TEST FOR GOODNESS OF FIT	
BASED ON R.O. GILBERT, 1987	DRAWING NUMBER
BY NORMAN STRAUB / CHECKED BY KMS	APPROVED BY / DATE 07/29/94

SAMPLE CALCULATION:

- DETERMINE DENOMINATOR (d) OF W-TEST STATISTIC.

$$d = \sum_{i=1}^{n} (x_i - \bar{x})^2 = \sum_{i=1}^{n} x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)^2$$

n = 11 Samples

NORMAL DISTRIBUTION		LOG-NORMAL DISTRIBUTION	
x_i	x_i^2	$\ln x_i$	$(\ln x_i)^2$
1.5	2.25	0.405	0.164
8.7	75.69	2.16	4.68
9.8	96.04	2.28	5.21
11.4	129.96	2.43	5.92
25	625	3.21	10.4
29.2	852.64	3.37	11.4
46.2	2134.44	3.83	14.7
47.8	2284.84	3.86	15.0
48.8	2381.44	3.89	15.1
71.3	5083.69	4.27	18.2
225	50625	5.42	29.3
Σ = 524.7	= 64,290.99	= 35.15	= 130.0

Normal

$$d = (64{,}290.99) - \frac{1}{11}\left[524.7\right]^2 = 39{,}262.8$$

Log normal

$$d = 130.0 - \frac{1}{11}\left[35.15\right]^2 = 17.7$$

CLIENT NAVY CLEAN - CTO 159 - NAWC WARMINSTER	JOB NUMBER 1412
SUBJECT SHAPIRO-WILK W-TEST FOR GOODNESS OF FIT	
BASED ON R.O. GILBERT, 1987	DRAWING NUMBER
BY NORMAN STRAUB / CHECKED BY KMS	APPROVED BY / DATE 07/29/94

Sample CALCULATION (CON'T.)

- COMPUTE k, where: $k = \frac{n}{2}$, IF n is even

  $k = \frac{n-1}{2}$, IF n is odd

  FOR $n=11$, $k = \frac{11-1}{2} = 5$

- DETERMINE COEFFICIENTS $a_1, a_2, \ldots, a_k$ FROM TABLE A6 (GILBERT, 1987).

  $n = 11$

  $a_1 = 0.5601$

  $a_2 = 0.3315$

  $a_3 = 0.2260$

  $a_4 = 0.1429$

  $a_5 = 0.0695$

- COMPUTE W-TEST STATISTIC

$$W = \frac{1}{d}\left[\sum_{i=1}^{k} a_i\left(X_{[n-i+1]} - X_i\right)\right]^2$$

	i	a_i	X_{n-i+1}	X_i	$a_i(X_{n-i+1} - X_i)$
Normal	1	0.5601	$X_{11} = 225$	$X_1 = 1.5$	125.2
	2	0.3315	$X_{10} = 71.3$	$X_2 = 8.7$	20.75
	3	0.2260	$X_9 = 48.8$	$X_3 = 9.8$	8.814
	4	0.1429	$X_8 = 47.8$	$X_4 = 11.4$	5.202
	5	0.0695	$X_7 = 46.2$	$X_5 = 25$	1.473
				$\Sigma =$	161.4
Log normal	1	0.5601	$X_{11} = 5.42$	$X_1 = 0.405$	2.808
	2	0.3315	$X_{10} = 4.27$	$X_2 = 2.16$	0.699
	3	0.2260	$X_9 = 3.89$	$X_3 = 2.28$	0.364
	4	0.1429	$X_8 = 3.86$	$X_4 = 2.43$	0.204
	5	0.0695	$X_7 = 3.83$	$X_5 = 3.21$	0.043
				$\Sigma =$	4.118

CLIENT NAVY CLEAN - CTO 159 - NAWC WARMINSTER	JOB NUMBER 1412
SUBJECT SHAPIRO-WILK W-TEST FOR GOODNESS OF FIT	
BASED ON R.O. GILBERT, 1987	DRAWING NUMBER
BY NORMAN STRAUB / CHECKED BY KMS	APPROVED BY / DATE 07/29/94

SAMPLE CALCULATION (CON'T)

- W-TEST STATISTIC (CON'T)

Normal

$$W = \frac{1}{39262.8}\left[161.4\right]^2 = 0.663$$

Lognormal

$$W = \frac{1}{17.7}\left[4.118\right]^2 = 0.958$$

- COMPARISON TO QUANTILE VALUE FROM TABLE A7 (GILBERT, 1987)

$n = 11$ $\quad W_{0.05} = 0.850$

Normal

$\Delta = W_{Table} - W_{Calc} = 0.850 - 0.663 = 0.187$ ⇒ ACCEPT NULL HYPOTHE

Lognormal

$\Delta = 0.850 - 0.958 = -0.108$ ⇒ REJECT NULL HYPOTHES

∴ DATA SET EXHIBITS NORMAL DISTRIBUTION CHARACTERISTICS

REFERENCE

GILBERT, RICHARD O. STATISTICAL METHODS FOR ENVIRONMENTAL POLLUTION MONITORING. 1987. VAN NOSTRAND REINHOLD, NEW YORK

Table A6 Coefficients a_i for the Shapiro-Wilk W Test for Normality

i \ n	2	3	4	5	6	7	8	9	10
1	0.7071	0.7071	0.6872	0.6646	0.6431	0.6233	0.6052	0.5888	0.5739
2	-	0.0000	0.1677	0.2413	0.2806	0.3031	0.3164	0.3244	0.3291
3	-	-	-	0.0000	0.0875	0.1401	0.1743	0.1976	0.2141
4	-	-	-	-	-	0.0000	0.0561	0.0947	0.1224
5	-	-	-	-	-	-	-	0.0000	0.0399

i \ n	11	12	13	14	15	16	17	18	19	20
1	0.5601	0.5475	0.5359	0.5251	0.5150	0.5056	0.4968	0.4886	0.4808	0.4734
2	0.3315	0.3325	0.3325	0.3318	0.3306	0.3290	0.3273	0.3253	0.3232	0.3211
3	0.2260	0.2347	0.2412	0.2460	0.2495	0.2521	0.2540	0.2553	0.2561	0.2565
4	0.1429	0.1586	0.1707	0.1802	0.1878	0.1939	0.1988	0.2027	0.2059	0.2085
5	0.0695	0.0922	0.1099	0.1240	0.1353	0.1447	0.1524	0.1587	0.1641	0.1686
6	0.0000	0.0303	0.0539	0.0727	0.0880	0.1005	0.1109	0.1197	0.1271	0.1334
7	-	-	0.0000	0.0240	0.0433	0.0593	0.0725	0.0837	0.0932	0.1013
8	-	-	-	-	0.0000	0.0196	0.0359	0.0496	0.0612	0.0711
9	-	-	-	-	-	-	0.0000	0.0163	0.0303	0.0422
10	-	-	-	-	-	-	-	-	0.0000	0.0140

i \ n	21	22	23	24	25	26	27	28	29	30
1	0.4643	0.4590	0.4542	0.4493	0.4450	0.4407	0.4366	0.4328	0.4291	0.4254
2	0.3185	0.3156	0.3126	0.3098	0.3069	0.3043	0.3018	0.2992	0.2968	0.2944
3	0.2578	0.2571	0.2563	0.2554	0.2543	0.2533	0.2522	0.2510	0.2499	0.2487
4	0.2119	0.2131	0.2139	0.2145	0.2148	0.2151	0.2152	0.2151	0.2150	0.2148
5	0.1736	0.1764	0.1787	0.1807	0.1822	0.1836	0.1848	0.1857	0.1864	0.1870
6	0.1399	0.1443	0.1480	0.1512	0.1539	0.1563	0.1584	0.1601	0.1616	0.1630
7	0.1092	0.1150	0.1201	0.1245	0.1283	0.1316	0.1346	0.1372	0.1395	0.1415
8	0.0804	0.0878	0.0941	0.0997	0.1046	0.1089	0.1128	0.1162	0.1192	0.1219
9	0.0530	0.0618	0.0696	0.0764	0.0823	0.0876	0.0923	0.0965	0.1002	0.1036
10	0.0263	0.0368	0.0459	0.0539	0.0610	0.0672	0.0728	0.0778	0.0822	0.0862
11	0.0000	0.0122	0.0228	0.0321	0.0403	0.0476	0.0540	0.0598	0.0650	0.0697
12	-	-	0.0000	0.0107	0.0200	0.0284	0.0358	0.0424	0.0483	0.0537
13	-	-	-	-	0.0000	0.0094	0.0178	0.0253	0.0320	0.0381
14	-	-	-	-	-	-	0.0000	0.0084	0.0159	0.0227
15	-	-	-	-	-	-	-	-	0.0000	0.0076

Source: From Shapiro and Wilk, 1965. Used by permission.
This table is used in Section 12.3.1.

Table A6 (continued)

f \ n	31	32	33	34	35	36	37	38	39	40
1	0.4220	0.4188	0.4156	0.4127	0.4096	0.4068	0.4040	0.4015	0.3989	0.3964
2	0.2921	0.2898	0.2876	0.2854	0.2834	0.2813	0.2794	0.2774	0.2755	0.2737
3	0.2475	0.2462	0.2451	0.2439	0.2427	0.2415	0.2403	0.2391	0.2380	0.2368
4	0.2145	0.2141	0.2137	0.2132	0.2127	0.2121	0.2116	0.2110	0.2104	0.2098
5	0.1874	0.1878	0.1880	0.1882	0.1883	0.1883	0.1883	0.1881	0.1880	0.1878
6	0.1641	0.1651	0.1660	0.1667	0.1673	0.1678	0.1683	0.1686	0.1689	0.1691
7	0.1433	0.1449	0.1463	0.1475	0.1487	0.1496	0.1505	0.1513	0.1520	0.1526
8	0.1243	0.1265	0.1284	0.1301	0.1317	0.1331	0.1344	0.1356	0.1366	0.1376
9	0.1066	0.1093	0.1116	0.1140	0.1160	0.1179	0.1196	0.1211	0.1225	0.1237
10	0.0899	0.0931	0.0961	0.0988	0.1013	0.1036	0.1056	0.1075	0.1092	0.1108
11	0.0739	0.0777	0.0812	0.0844	0.0873	0.0900	0.0924	0.0947	0.0967	0.0986
12	0.0585	0.0629	0.0669	0.0706	0.0739	0.0770	0.0798	0.0824	0.0848	0.0870
13	0.0435	0.0485	0.0530	0.0572	0.0610	0.0645	0.0677	0.0706	0.0733	0.0759
14	0.0289	0.0344	0.0395	0.0441	0.0484	0.0523	0.0559	0.0592	0.0622	0.0651
15	0.0144	0.0206	0.0262	0.0314	0.0361	0.0404	0.0444	0.0481	0.0515	0.0546
16	0.0000	0.0068	0.0131	0.0187	0.0239	0.0287	0.0331	0.0372	0.0409	0.0444
17	-	-	0.0000	0.0062	0.0119	0.0172	0.0220	0.0264	0.0305	0.0343
18	-	-	-	-	0.0000	0.0057	0.0110	0.0158	0.0203	0.0244
19	-	-	-	-	-	-	0.0000	0.0053	0.0101	0.0146
20	-	-	-	-	-	-	-	-	0.0000	0.0049

f \ n	41	42	43	44	45	46	47	48	49	50
1	0.3940	0.3917	0.3894	0.3872	0.3850	0.3830	0.3808	0.3789	0.3770	0.3751
2	0.2719	0.2701	0.2684	0.2667	0.2651	0.2635	0.2620	0.2604	0.2589	0.2574
3	0.2357	0.2345	0.2334	0.2323	0.2313	0.2302	0.2291	0.2281	0.2271	0.2260
4	0.2091	0.2085	0.2078	0.2072	0.2065	0.2058	0.2052	0.2045	0.2038	0.2032
5	0.1876	0.1874	0.1871	0.1868	0.1865	0.1862	0.1859	0.1855	0.1851	0.1847
6	0.1693	0.1694	0.1695	0.1695	0.1695	0.1695	0.1695	0.1693	0.1692	0.1691
7	0.1531	0.1535	0.1539	0.1542	0.1545	0.1548	0.1550	0.1551	0.1553	0.1554
8	0.1384	0.1392	0.1398	0.1405	0.1410	0.1415	0.1420	0.1423	0.1427	0.1430
9	0.1249	0.1259	0.1269	0.1278	0.1286	0.1293	0.1300	0.1306	0.1312	0.1317
10	0.1123	0.1136	0.1149	0.1160	0.1170	0.1180	0.1189	0.1197	0.1205	0.1212
11	0.1004	0.1020	0.1035	0.1049	0.1062	0.1073	0.1085	0.1095	0.1105	0.1113
12	0.0891	0.0909	0.0927	0.0943	0.0959	0.0972	0.0986	0.0998	0.1010	0.1020
13	0.0782	0.0804	0.0824	0.0842	0.0860	0.0876	0.0892	0.0906	0.0919	0.0932
14	0.0677	0.0701	0.0724	0.0745	0.0765	0.0783	0.0801	0.0817	0.0832	0.0846
15	0.0575	0.0602	0.0628	0.0651	0.0673	0.0694	0.0713	0.0731	0.0748	0.0764
16	0.0476	0.0506	0.0534	0.0560	0.0584	0.0607	0.0628	0.0648	0.0667	0.0685
17	0.0379	0.0411	0.0442	0.0471	0.0497	0.0522	0.0546	0.0568	0.0588	0.0608
18	0.0283	0.0318	0.0352	0.0383	0.0412	0.0439	0.0465	0.0489	0.0511	0.0532
19	0.0188	0.0227	0.0263	0.0296	0.0328	0.0357	0.0385	0.0411	0.0436	0.0459
20	0.0094	0.0136	0.0175	0.0211	0.0245	0.0277	0.0307	0.0335	0.0361	0.0386
21	0.0000	0.0045	0.0087	0.0126	0.0163	0.0197	0.0229	0.0259	0.0288	0.0314
22	-	-	0.0000	0.0042	0.0081	0.0118	0.0153	0.0185	0.0215	0.0244
23	-	-	-	-	0.0000	0.0039	0.0076	0.0111	0.0143	0.0174
24	-	-	-	-	-	-	0.0000	0.0037	0.0071	0.0104
25	-	-	-	-	-	-	-	-	0.0000	0.0035

Table A7 Quantiles of the Shapiro-Wilk W Test for Normality (Values of W Such That $100p\%$ of the Distribution of W Is Less Than W_p)

n	$W_{0.01}$	$W_{0.02}$	$W_{0.05}$	$W_{0.10}$	$W_{0.50}$
3	0.753	0.756	0.767	0.789	0.959
4	0.687	0.707	0.748	0.792	0.935
5	0.686	0.715	0.762	0.806	0.927
6	0.713	0.743	0.788	0.826	0.927
7	0.730	0.760	0.803	0.838	0.928
8	0.749	0.778	0.818	0.851	0.932
9	0.764	0.791	0.829	0.859	0.935
10	0.781	0.806	0.842	0.869	0.938
11	0.792	0.817	0.850	0.876	0.940
12	0.805	0.828	0.859	0.883	0.943
13	0.814	0.837	0.866	0.889	0.945
14	0.825	0.846	0.874	0.895	0.947
15	0.835	0.855	0.881	0.901	0.950
16	0.844	0.863	0.887	0.906	0.952
17	0.851	0.869	0.892	0.910	0.954
18	0.858	0.874	0.897	0.914	0.956
19	0.863	0.879	0.901	0.917	0.957
20	0.868	0.884	0.905	0.920	0.959
21	0.873	0.888	0.908	0.923	0.960
22	0.878	0.892	0.911	0.926	0.961
23	0.881	0.895	0.914	0.928	0.962
24	0.884	0.898	0.916	0.930	0.963
25	0.886	0.901	0.918	0.931	0.964
26	0.891	0.904	0.920	0.933	0.965
27	0.894	0.906	0.923	0.935	0.965
28	0.896	0.908	0.924	0.936	0.966
29	0.898	0.910	0.926	0.937	0.966
30	0.900	0.912	0.927	0.939	0.967
31	0.902	0.914	0.929	0.940	0.967
32	0.904	0.915	0.930	0.941	0.968
33	0.906	0.917	0.931	0.942	0.968
34	0.908	0.919	0.933	0.943	0.969
35	0.910	0.920	0.934	0.944	0.969
36	0.912	0.922	0.935	0.945	0.970
37	0.914	0.924	0.936	0.946	0.970
38	0.916	0.925	0.938	0.947	0.971
39	0.917	0.927	0.939	0.948	0.971
40	0.919	0.928	0.940	0.949	0.972
41	0.920	0.929	0.941	0.950	0.972
42	0.922	0.930	0.942	0.951	0.972
43	0.923	0.932	0.943	0.951	0.973
44	0.924	0.933	0.944	0.952	0.973
45	0.926	0.934	0.945	0.953	0.973
46	0.927	0.935	0.945	0.953	0.974
47	0.928	0.936	0.946	0.954	0.974
48	0.929	0.937	0.947	0.954	0.974
49	0.929	0.937	0.947	0.955	0.974
50	0.930	0.938	0.947	0.955	0.974

Source: After Shapiro and Wilk, 1965.

The null hypothesis of a normal distribution is rejected at the α significance level if the calculated W is less than W_α.

This table is used in Section 12.3.1.

CLIENT NAVY CLEAN - CTO 159 - NAWC WARMINSTER		JOB NUMBER 1412	
SUBJECT RISK ASSESSMENT CALCULATIONS			
BASED ON USEPA, December 1989 & January 1992		DRAWING NUMBER	
BY Norman J. Straub NJS	CHECKED BY AEH	APPROVED BY	DATE 06/15/94

PURPOSE: QUANTIFY CHEMICAL EXPOSURE AND ASSOCIATER RISKS FOR HUMAN RECEPTORS IN CONTACT WITH GROUNDWATER UNDER RESIDENTIAL CONDITIONS.

RELEVANT EQUATIONS:

- INGESTION OF GROUNDWATER

$$Dose = \frac{C_{water} \times IngR \times EF \times ED}{BW \times AT}$$

Where:

Dose	=	Dose estimate (mg/Kg-day)
C_{water}	=	Groundwater exposure concentration (mg/L)
IngR	=	Ingestion rate (L/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (period of time over which exposure is averaged - days)

- DERMAL CONTACT WITH GROUNDWATER (WHILE BATHING, SHOWERING, ETC)

$$Dose = \frac{C_{water} \times PC \times SA \times ET \times EF \times ED \times CF}{BW \times AT}$$

Where:

Dose	=	Absorbed chemical dose (mg/Kg-day)
C_{water}	=	Groundwater exposure concentration (mg/L)
PC	=	Dermal permeability constant of chemical (cm/hour)
SA	=	Skin surface area available for contact (cm^2)
CF	=	Conversion Factor ($L/10^3$ cm^3)

CLIENT	JOB NUMBER
NAVY CLEAN - CTO 159 - NAWC WARMINSTER	1412
SUBJECT: RISK ASSESSMENT CALCULATION	
BASED ON: USEPA, December 1989 & JANUARY 1992	DRAWING NUMBER
BY: NORMAN J STRAUB	CHECKED BY: AEH / APPROVED BY: / DATE: 06/15/94

RELEVANT EQUATIONS (CON'T).

- INHALATION OF VOLATILES EMITTED DURING SHOWERING

$$Dose = \frac{S \times K \times InhR \times EF \times ED \times CF}{BW \times AT \times R_a}$$

and

$$K = D_s + \frac{\exp^{-R_a \times D_t}}{R_a} - \frac{\exp^{R_a(D_s - D_t)}}{R_a}$$

Where:

Dose	=	Inhalation exposure dose (mg/Kg-day)
S	=	Volatile Chemical Generation Rate ($\mu g/m^3$-min)
InhR	=	Inhalation Rate (L/min)
EF	=	Exposure Frequency (day^{-1})
ED	=	Exposure Duration (years)
BW	=	Body Weight (Kg)
AT	=	Averaging Time (period of time over which exposure is averaged - days)
R_a	=	Air exchange Rate (min^{-1})
K	=	Constant (min)
D_s	=	Shower Duration (min)
D_t	=	Total Time in Bathroom (min)
CF	=	Conversion Factor (10^{-6} mg-$m^3/\mu g$-L)

- HAZARD QUOTIENT

$$Hazard\ Quotient\ (HQ) = \frac{Dose}{RfD}$$

CLIENT NAVY CLEAN-CTO 159 - NAWC WARMINSTER		JOB NUMBER 1412	
SUBJECT RISK ASSESSMENT CALCULATIONS			
BASED ON USEPA, DECEMBER 1989 & JANUARY 1992		DRAWING NUMBER	
BY NORMAN J. STRAUB	CHECKED BY	APPROVED BY	DATE 06/15/94

- INCREMENTAL CANCER RISK

$$\text{Incremental Cancer Risk (ICR)} = \text{Dose} \times \text{CSF}$$

If the above equation results in a risk greater than 0.01, the following equation is used:

$$ICR = 1 - \exp^{(-Dose \times CSF)}$$

- DERMAL ABSORPTION ADJUSTMENT

Reference Doses

$$RfD_{Dermal} = \frac{RfD_{oral}}{ABS_{GI}}$$

Cancer Slope Factors

$$CSF_{Dermal} = CSF_{Oral} \times ABS_{GI}$$

WHERE: ABS_{GI} = ABSORPTION FRACTION VIA DIGESTIVE TRACT OF ADMINISTERED DOSE.

CLIENT	JOB NUMBER
NAVY CLEAN - CTO 159 - NAWC WARMINSTER	1412
SUBJECT: RISK ASSESSMENT CALCULATION	
BASED ON: USEPA, DECEMBER 1989 & JANUARY 1992	DRAWING NUMBER
BY: NORMAN J. STRAUB	CHECKED BY: [illegible] / APPROVED BY	DATE: 06/15/94

ASSUMPTIONS:

- THE FOLLOWING EXPOSURE ASSESSMENT INPUT PARAMETERS ARE USED:

SUMMARY OF EXPOSURE ASSESSMENT INPUT PARAMETERS
RESIDENTIAL GROUNDWATER EXPOSURES - AREA C
NAWC WARMINSTER, PENNSYLVANIA

Parameter	Value	Rationale/Source
Chemical concentration in groundwater (C_{water})	Maximum chemical-specific concentration (mg/L)	Conservative value for risk assessment
Groundwater ingestion rate (IngR)	2 L/day (adult) 1 L/day (child)	USEPA, December 1989 and March 25, 1991
Air inhalation rate (InhR)	20 m^3/day 14 L/min	Outdoor air respiration rate/ USEPA, March 25, 1991
Dermal permeability constant (PC)	Chemical specific value (cm/hr)	USEPA, January 1992
Skin surface area available for contact (SA)	19,400 cm^2 (adult) 7,280 cm^2 (child)	USEPA, May 1989 and December 1989
Volatile chemical generation rate (S)	Chemical specific rate ($\mu g/m^3$-min)	Foster and Chrostowski, 1987
Inhalation exposure time constant (K)	41.6 min	Calculated value
Exposure time (ET)	0.25 hr	Estimate of time spent in shower
Exposure frequency (EF)	350 days/yr	USEPA, December 1989 and March 25, 1991
Exposure duration (ED)	30 yr (adult) 6 yr (child)	USEPA, December 1989 and March 25, 1991
Body weight (BW)	70 Kg (adult) 15 Kg (child)	USEPA, December 1989 and March 25, 1991
Averaging time (AT)	ED x 365 days/yr (noncarcinogens) 70 yr x 365 days/yr (carcinogens)	USEPA, December 1989 and March 25, 1991
Bathroom air exchange rate (Ra)	0.0083 min^{-1}	Foster and Chrostowski, 1987
Time spent in shower/bath (D_1)	15 min	Estimated value
Time spent in bathroom (D_2)	20 min	Estimated value

CLIENT	JOB NUMBER
NAVY CLEAN-CTO159-NAWC WARMINSTER	1412

SUBJECT: RISK ASSESSMENT CALCULATION

BASED ON	DRAWING NUMBER
USEPA, DECEMBER 1989 & JANUARY 1992	

BY	CHECKED BY	APPROVED BY	DATE
NORMAN J. STRAUB			06/15/94

ASSUMPTIONS (CON'T):

FOR TETRACHLOROETHENE, THE FOLLOWING TOXICITY DATA ARE AVAILABLE:

EXPOSURE ROUTE	RfD (mg/kg·day)	CSF (kg·day/mg)
Oral	1×10^{-2}	5.2×10^{-2}
Inhalation	1×10^{-2}	2.0×10^{-3}

$ABS_{GI} = 100\%$ $PC = 4.8 \times 10^{-2}$ cm/HR

$C_W = 0.031$ mg/L

SAMPLE CALCULATION

- INGESTION EXPOSURE DOSE (ADULT RECEPTOR)

$$DOSE = \frac{C_W \times IngR \times EF \times ED}{BW \times AT}$$

$$DOSE_{NCarc} = \frac{(0.031\ mg/L)(2\ L/day)(350\ day/YR)(30\ YR)}{(70\ kg)(30\ YR)(365\ day/YR)}$$

$$DOSE_{Carc} = \frac{(0.031\ mg/L)(2\ L/day)(350\ day/YR)(30\ YR)}{(70\ kg)(70\ YR)(365\ day/YR)}$$

$$\boxed{\begin{aligned} DOSE_{NCarc} &= 8.5 \times 10^{-4}\ mg/kg\cdot day \\ DOSE_{Carc} &= 3.6 \times 10^{-4}\ mg/kg\cdot day \end{aligned}}$$

CLIENT	JOB NUMBER		
NAVY CLEAN - CTO 159 - NAWC WARMINSTER	1412		
SUBJECT: RISK ASSESSMENT CALCULATION			
BASED ON: USEPA, DECEMBER 1989 & JANUARY 1992	DRAWING NUMBER		
BY: NORMAN J. STRAUB	CHECKED BY: AGH	APPROVED BY	DATE: 06/15/94

SAMPLE CALCULATION (CON'T.)

- DERMAL EXPOSURE DOSE (ADULT RECEPTOR)

$$DOSE = \frac{C_W \times PC \times SA \times ET \times EF \times ED \times CF}{BW \times AT}$$

$$DOSE_{NCarc} = \frac{(0.031\ mg/L)(4.8\times10^{-2}\ cm/HR)(19{,}400\ cm^2)(0.25\ \frac{HR}{day})(350\ day/YR)(30\ YR)(L/10^3 cm^3)}{(70\ kg)(30\ YR)(365\ day/YR)}$$

$$\boxed{DOSE_{NCarc} = 9.9\times10^{-5}\ mg/kg\cdot day}$$ ✓

$$DOSE_{Carc} = \frac{(0.031\ mg/L)(4.8\times10^{-2}\ cm/HR)(19400\ cm^2)(0.25\ \frac{HR}{day})(350\ day/YR)(30\ YR)(L/10^3 cm^3)}{(70\ kg)(70\ YR)(365\ day/YR)}$$

$$\boxed{DOSE_{Carc} = 4.2\times10^{-5}\ mg/kg\cdot day}$$ ✓

- INHALATION of VOLATILE EMISSIONS FROM SHOWERING

$$K = D_S + \frac{\exp(-R_a \times D_t)}{R_a} - \frac{\exp(R_a(D_S - D_t))}{R_a}$$

$$= (15\ min) + \frac{\exp[(-0.0083\ min^{-1})(20\ min)]}{0.0083\ min^{-1}} - \frac{\exp[0.0083\ min^{-1}(15\ min - 20\ min)]}{0.0083\ min^{-1}}$$

115.6 min

$$\boxed{K = 1.45\ min = 0.024\ HR}$$

CLIENT	JOB NUMBER
NAVY CLEAN - CTO 159 - NAWC WARMINSTER	1412
SUBJECT: RISK ASSESSMENT CALCULATION	
BASED ON: USEPA, DECEMBER 1989 & JANUARY 1992	DRAWING NUMBER
BY: NORMAN J. STRAUB	CHECKED BY: APPROVED BY: DATE

SAMPLE CALCULATIONS (CON'T)

- VOLATILE CHEMICAL EMISSION RATE

$$S = \frac{C_{water} \times FR}{SV}$$; FR = SHOWER FLOW RATE (L/min), SV = SHOWER ROOM VOLUME (m^3)

$$S = \frac{(11.1\ \mu g/L)(10\ L/min)}{12\ m^3} = 9.31\ \mu g/min \cdot m^3$$ ✓

- CHEMICAL CONCENTRATION IN DROPLET VAPOR ($\mu g/L$ - C_{wd})

$$C_{wd} = C_{wo}\left[1 - \exp\left(-\frac{K_{al}\, t_s}{60\, d}\right)\right]$$; C_{wo} = CHEMICAL CONC. IN GW ($\mu g/L$)

$$C_{wd} = \left(0.031\ \frac{mg}{L}\right)\left[1 - \exp\left(\frac{(-13.4\ cm/HR)(2\ sec)}{(60\ \frac{cm \cdot sec}{HR \cdot min})(1\ min)}\right)\right]$$

$$C_{wd} = 0.0111\ mg/L$$ ✓

- ADJUSTED MASS TRANSFER COEFFICIENT (K_{al})

$$K_{al} = K_L\left(\frac{T_1 M_2}{T_2 M_1}\right)^{-1/2}$$

$$K_{al} = \left(10.2\ \frac{cm}{HR}\right)\left(\frac{(293\ K)(0.616\ cp)}{(318\ K)(0.982\ cp)}\right)^{-1/2}$$

$$K_{al} = 13.4\ cm/HR$$ ✓

- MASS TRANSFER COEFFICIENT (K_L) FOR PCE, MW = 165.83

$$K_L = \left[\frac{1}{K_l} + \frac{RT}{HK_g}\right]^{-1}$$; $K_l = \left(\frac{20\ cm}{HR}\right)\left(\frac{44}{MW}\right)^{1/2} = \left(\frac{20\ cm}{HR}\right)\left(\frac{44}{165.83}\right)^{1/2} = 10.3\ cm/HR$

$K_g = \left(\frac{3000\ cm}{HR}\right)\left(\frac{18}{MW}\right)^{1/2} = \left(\frac{3000\ cm}{HR}\right)\left(\frac{18}{165.83}\right)^{1/2} = 988\ cm/HR$

$$K_L = \left[\frac{1}{10.3\ \frac{cm}{HR}} + \frac{(8.2\times10^{-5}\ \frac{atm\ m^3}{mol\ K})(293\ K)}{(2.69\times10^{-2}\ \frac{atm\ m^3}{mol})(988\ cm/HR)}\right]^{-1} = 10.2\ cm/HR$$ ✓

CLIENT	JOB NUMBER		
NAVY CLEAN - CTO 159 - NAWC WARMINSTER	1412		
SUBJECT: RISK ASSESSMENT CALCULATION			
BASED ON: USEPA, DECEMBER 1989 & JANUARY 1992		DRAWING NUMBER	
BY: NORMAN J. STRAUB NJS	CHECKED BY: AEH	APPROVED BY	DATE: 06/15/94

SAMPLE CALCULATIONS (CON'T)

- INHALATION of VOLATILES EMITTED FROM SHOWERING (CON'T)

$$DOSE = \frac{S \times K \times InhR \times EF \times EF \times ED \times CF}{BW \times AT \times Ra}$$

$$DOSE_{NCare} = \frac{(9.31\ \mu g/min \cdot m^3)(1.45\ min)(14\ L/min)(350\ \frac{showers}{YR})(30\ YR)(10^{-3}\ mg/\mu g)(10^{-3}\ m^3/L)}{(70\ kg)(30\ YR)(365\ day/YR)(0.0083\ min^{-1})}$$

$$\boxed{DOSE_{NCare} = 3.2 \times 10^{-4}\ mg/kg \cdot day}$$

$$DOSE_{Care} = \frac{(9.31\ \mu g/min \cdot m^3)(1.45\ min)(14\ L/min)(350\ Shower/YR)(30\ YR)(10^{-3}\ mg/\mu g)(10^{-3}\ m^3/L)}{(70\ kg)(70\ YR)(365\ d/YR)(0.0083\ min^{-1})}$$

$$\boxed{DOSE_{Care} = 1.4 \times 10^{-4}\ mg/kg\ day}$$

- DERMAL ABSORPTION ADJUSTMENT

REFERENCE DOSE -

$$RfD_{Derm} = \frac{RfD_{oral}}{ABS_{GI}} = \frac{1 \times 10^{-2}}{1.00} = \underline{1 \times 10^{-2}\ mg/kg \cdot day}$$

$$CSF_{Derm} = (CSF_{oral})(ABS_{GI}) = (5.2 \times 10^{-2})(1.00) = \underline{5.2 \times 10^{-2}\ (\frac{kg \cdot day}{mg})}$$

CLIENT NAVY CLEAN-CTO159-NAWC WARMINSTER	JOB NUMBER 1424
SUBJECT RISK ASSESSMENT CALCULATION.	
BASED ON USEPA, DECEMBER 1989 & JANUARY 1992	DRAWING NUMBER
BY AKS / CHECKED BY AGH	APPROVED BY / DATE 06/15/94

SAMPLE CALCULATIONS (CONT).

- HAZARD QUOTIENTS

$$HQ_{ING} = \frac{Dose_{ING}}{RfD_{oral}} = \frac{8.5\times10^{-4}\ mg/kg\cdot day}{1\times10^{-2}\ mg/kg\ day} = \underline{8.5\times10^{-2}}$$

$$HQ_{Derm} = \frac{Dose_{derm}}{RfD_{Derm}} = \frac{9.9\times10^{-5}\ mg/kg\ day}{1\times10^{-2}\ mg/kg\cdot day} = \underline{9.9\times10^{-3}}$$

$$HQ_{inh} = \frac{Dose_{inh}}{RfD_{inh}} = \frac{3.2\times10^{-4}}{1\times10^{-2}} = \underline{3.2\times10^{-2}}$$

$$HI_{PCE} = \boxed{1.3\times10^{-1}}$$

- INCREMENTAL CANCER RISK

$$ICR_{ING} = \left(3.6\times10^{-4}\ \frac{mg}{kg\cdot day}\right)\left(5.2\times10^{-2}\ \frac{kg\cdot day}{mg}\right) = \underline{1.9\times10^{-5}}$$

$$ICR_{Derm} = \left(4.2\times10^{-5}\ mg/kg\cdot day\right)\left(5.2\times10^{-2}\ \frac{kg\cdot day}{mg}\right) = \underline{2.2\times10^{-6}}$$

$$ICR_{inh} = \left(1.4\times10^{-4}\ mg/kg\ day\right)\left(2.0\times10^{-3}\ \frac{kg\cdot days}{mg}\right) = \underline{2.8\times10^{-7}}$$

$$ICR_{PCE} = \boxed{2.1\times10^{-5}}$$

CLIENT	JOB NUMBER		
NAVY CLEAN-CTO159-NAWC WARMINSTER	1424		
SUBJECT RISK ASSESSMENT CALCULATIONS			
BASED ON USEPA, DECEMBER 1989 & JANUARY 1992	DRAWING NUMBER		
BY NORMAN J STRAND	CHECKED BY ACH	APPROVED BY	DATE 06/15/94

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RISK ASSESSMENT SPREADSHEET - EXPOSURES THROUGH HOUSEHOLD USE OF GROUNDWATER

SITE NAME: NAWC WARMINSTER
LOCATION: AREA C - Off site resident maximum PCE concentration
DATE: 06/08/94

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS. THREE EXPOSURE ROUTES ARE CONSIDERED: INGESTION OF GROUNDWATER, INHALATION OF VOLATILES DURING SHOWERING/BATHING, AND DERMAL CONTACT WHILE SHOWERING/BATHING. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO:

REFERENCES: EPA, DECEMBER 1989
FOSTER AND CHROSTOWSKI, 1987

INGESTION: IEX = (C x IR x EF x ED)/(BW x AT)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
IR = INGESTION RATE (LITERS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

DERMAL CONTACT: DEX = (C x PC x AV x ET x EF x ED)/(BW x AT x 1000)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
PC = THE PERMEABILITY CONSTANT OF CHEMICAL (CM/HR)
AV = THE SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
ET = EXPOSURE TIME (HRS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

INHALATION: IEX = (S x IR x EF x ED)/(BW x AT x Ra x 1E3)x(Ds + EXP(-Ra x Dt)/Ra - EXP(Ra x (Ds-Dt))/Ra)

WHERE:
S = VOLATILE ORGANIC CHEMICAL GENERATION RATE (UG/CUBIC METER/MIN)
IR = INHALATION RATE (LITERS/MIN)
Ds = SHOWER DURATION (MIN)
Ra = AIR EXCHANGE RATE (1/MIN)
Dt = TOTAL DURATION IN SHOWER ROOM (MIN)
BW = BODY WEIGHT (KG)
SV = SHOWER ROOM AIR VOLUME (m**3)
R = IDEAL GAS LAW CONSTANT (ATM-M**3/MOL/K)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
AT = AVERAGING TIME (DAYS)

INPUT PARAMETERS:

INGESTION: ADULT EXPOSURE

IR:	2 L/day	CONVERSION	
EF:	350 days/yr	FACTOR (NONCAR) =	2.74E-02
ED:	30 yr		
BW:	70 Kg	CONVERSION	
AT(NON):	10950 days	FACTOR (CARCIN) =	1.17E-02
AT(CAR):	25550 days		

DERMAL CONTACT: ADULT EXPOSURE

AV:	19400 cm2	CONVERSION	
ET:	0.25 hr	FACTOR (NONCAR) =	6.64E-02
EF:	350 days/yr		
ED:	30 yr	CONVERSION	
BW:	70 Kg	FACTOR (CARCIN) =	2.85E-02
AT (NON):	10950 days		
AT (CAR):	25550 days		

INHALATION: ADULT EXPOSURE

IR:	14 m3/day	d:	1 mm	
BW:	70 Kg	ts:	2 sec	
Ds:	15 min	T1:	293 K	
Dt:	20 min	Ts:	318 K	
Ra:	0.0083 1/min	M1:	0.982 centipoise	
SV:	12 m3	M2:	0.616 centipoise	
ED:	30 yr	T:	293 K	
R:	0.000082 atm-m3/mol-K	FR:	10 L/min	
EF:	350 days/yr	AT:	10950 (NONCAR)	25550 (CARCIN)

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE TWO)

CALCULATE DOSES:

CHEMICAL	GW CONC. (MG/L)	MOLECULAR WEIGHT	HENRYS LAW CONSTANT	MASS TRANSFER COEFFICIENT (KA)	DERMAL PERM. CONSTANT	AIR CONCENTRATION (MG-MIN/L/SHOWER)
Tetrachloroethene	0.031	165.83	2.69E-02	1.34E+01	4.80E-02	1.65E-03
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00

RISK ASSESSMENT SPREADSHEET - HOUSEHOLD USE OF GROUNDWATER (PAGE THREE)

CALCULATE HAZARD INDICES:

CHEMICAL	ANNUAL INGESTION DOSE	ANNUAL DERMAL DOSE	ANNUAL INHALATION DOSE	INGESTION RfD	DERMAL RfD	INHALATION RfD	HAZARD INDEX INGESTION	HAZARD INDEX DERMAL	HAZARD INDEX INHALATION	TOTAL HAZARD INDEX
Tetrachloroethene	8.49E-04	9.89E-05	3.16E-04	1.00E-02	1.00E-02	1.00E-02	8.49E-02	9.89E-03	3.16E-02	1.26E-01
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL HAZARD INDEX							8.49E-02	9.89E-03	3.16E-02	1.26E-01

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE FOUR)

CALCULATE INCREMENTAL CANCER RISK.

CHEMICAL	LIFETIME AVG INGESTION DOSE	LIFETIME AVG DERMAL DOSE	LIFETIME AVG INHALATION DOSE	CSF INGESTION	CSF DERMAL	CSF INHALATION	CANCER RISK INGESTION	CANCER RISK DERMAL	CANCER RISK INHALATION	TOTAL CANCER RISK
Tetrachloroethene	3.64E-04	4.24E-05	1.36E-04	5.20E-02	5.20E-02	2.00E-03	1.89E-05	2.20E-06	2.71E-07	2.14E-05
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL RISK							1.89E-05	2.20E-06	2.71E-07	2.14E-05

RISK ASSESSMENT SPREADSHEET – EXPOSURES THROUGH HOUSEHOLD USE OF GROUNDWATER

SITE NAME: NAWC WARMINSTER
LOCATION: AREA C – Offsite resident maximum PCE concentration
DATE: 06/08/94

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS. THREE EXPOSURE ROUTES ARE CONSIDERED: INGESTION OF GROUNDWATER, INHALATION OF VOLATILES DURING SHOWERING/BATHING, AND DERMAL CONTACT WHILE SHOWERING/BATHING. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO:

REFERENCES: EPA, DECEMBER 1989
FOSTER AND CHROSTOWSKI, 1987

INGESTION: IEX = (C x IR x EF x ED)/(BW x AT)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
IR = INGESTION RATE (LITERS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

DERMAL CONTACT: DEX = (C x PC x AV x ET x EF x ED)/(BW x AT x 1000)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
PC = THE PERMEABILITY CONSTANT OF CHEMICAL (CM/HR)
AV = THE SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
ET = EXPOSURE TIME (HRS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

INHALATION: IEX = (S x IR x EF x ED)/(BW x AT x Ra x 1E3)x(Ds + EXP(–Ra x Dt)/Ra – EXP(Ra x (Ds–Dt))/Ra)

WHERE:
S = VOLATILE ORGANIC CHEMICAL GENERATION RATE (UG/CUBIC METER/MIN)
IR = INHALATION RATE (LITERS/MIN)
Ds = SHOWER DURATION (MIN)
Ra = AIR EXCHANGE RATE (1/MIN)
Dt = TOTAL DURATION IN SHOWER ROOM (MIN)
BW = BODY WEIGHT (KG)
SV = SHOWER ROOM AIR VOLUME (m**3)
R = IDEAL GAS LAW CONSTANT (ATM–M**3/MOL/K)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
AT = AVERAGING TIME (DAYS)

INPUT PARAMETERS:

INGESTION: CHILD EXPOSURE

IR:	1 L/day	CONVERSION	
EF:	350 days/yr	FACTOR (NONCAR) =	6.39E–02
ED:	6 yr		
BW:	15 Kg	CONVERSION	
AT(NON):	2190 days	FACTOR (CARCIN) =	5.48E–03
AT(CAR):	25550 days		

DERMAL CONTACT: CHILD EXPOSURE

AV:	7280 cm2	CONVERSION	
ET:	0.25 hr	FACTOR (NONCAR) =	1.16E–01
EF:	350 days/yr		
ED:	6 yr	CONVERSION	
BW:	15 Kg	FACTOR (CARCIN) =	9.97E–03
AT (NON):	2190 days		
AT (CAR):	25550 days		

INHALATION: CHILD EXPOSURE

IR:	0 m3/day	d:	1 mm	
BW:	15 Kg	ts:	2 sec	
Ds:	15 min	T1:	293 K	
Dt:	20 min	Ts:	318 K	
Ra:	0.0083 1/min	M1:	0.982 centipoise	
SV:	12 m3	M2:	0.616 centipoise	
ED:	30 yr	T:	293 K	
R:	0.000082 atm–m3/mol–K	FR:	10 L/min	
EF:	350 days/yr	AT:	10950 (NONCAR)	25550 (CARCIN)

RISK ASSESSMENT SPREADSHEET - HOUSEHOLD USE OF GROUNDWATER (PAGE TWO)

CALCULATE DOSES:

CHEMICAL	GW CONC. (MG/L)	MOLECULAR WEIGHT	HENRYS LAW CONSTANT	MASS TRANSFER COEFFICIENT (KA)	DERMAL PERM. CONSTANT	AIR CONCENTRATION (MG-MIN/L/SHOWER)
Tetrachloroethene	0.031	165.83	2.69E-02	1.34E+01	4.80E-02	1.65E-03
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00

RISK ASSESSMENT SPREADSHEET - HOUSEHOLD USE OF GROUNDWATER (PAGE THREE)

CALCULATE HAZARD INDICES:

CHEMICAL	ANNUAL INGESTION DOSE	ANNUAL DERMAL DOSE	ANNUAL INHALATION DOSE	INGESTION RfD	DERMAL RfD	INHALATION RfD	HAZARD INDEX INGESTION	HAZARD INDEX DERMAL	HAZARD INDEX INHALATION	TOTAL HAZARD INDEX
Tetrachloroethene	1.98E-03	1.73E-04	0.00E+00	1.00E-02	1.00E-02	1.00E-02	1.98E-01	1.73E-02	0.00E+00	2.15E-01
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL HAZARD INDEX							1.98E-01	1.73E-02	0.00E+00	2.15E-01

RISK ASSESSMENT SPREADSHEET – EXPOSURES THROUGH HOUSEHOLD USE OF GROUNDWATER

SITE NAME: NAWC WARMINSTER
LOCATION: AREA C – Future resident adult
DATE: 07/28/94

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS. THREE EXPOSURE ROUTES ARE CONSIDERED: INGESTION OF GROUNDWATER, INHALATION OF VOLATILES DURING SHOWERING/BATHING, AND DERMAL CONTACT WHILE SHOWERING/BATHING. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO:

REFERENCES: EPA, DECEMBER 1989
FOSTER AND CHROSTOWSKI, 1987

INGESTION: IEX = (C x IR x EF x ED)/(BW x AT)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
IR = INGESTION RATE (LITERS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

DERMAL CONTACT: DEX = (C x PC x AV x ET x EF x ED)/(BW x AT x 1000)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
PC = THE PERMEABILITY CONSTANT OF CHEMICAL (CM/HR)
AV = THE SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
ET = EXPOSURE TIME (HRS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

INHALATION: IEX = (S x IR x EF x ED)/(BW x AT x Ra x 1E3)x(Ds + EXP(–Ra x Dt)/Ra – EXP(Ra x (Ds–Dt))/Ra)

WHERE:
S = VOLATILE ORGANIC CHEMICAL GENERATION RATE (UG/CUBIC METER/MIN)
IR = INHALATION RATE (LITERS/MIN)
Ds = SHOWER DURATION (MIN)
Ra = AIR EXCHANGE RATE (1/MIN)
Dt = TOTAL DURATION IN SHOWER ROOM (MIN)
BW = BODY WEIGHT (KG)
SV = SHOWER ROOM AIR VOLUME (m**3)
R = IDEAL GAS LAW CONSTANT (ATM–M**3/MOL/K)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
AT = AVERAGING TIME (DAYS)

INPUT PARAMETERS:

INGESTION: ADULT EXPOSURE

IR:	2 L/day	CONVERSION	
EF:	350 days/yr	FACTOR (NONCAR) =	2.74E–02
ED:	30 yr		
BW:	70 Kg	CONVERSION	
AT(NON):	10950 days	FACTOR (CARCIN) =	1.17E–02
AT(CAR):	25550 days		

DERMAL CONTACT: ADULT EXPOSURE

AV:	19400 cm2	CONVERSION	
ET:	0 hr	FACTOR (NONCAR) =	0.00E+00
EF:	350 days/yr		
ED:	30 yr	CONVERSION	
BW:	70 Kg	FACTOR (CARCIN) =	0.00E+00
AT (NON):	10950 days		
AT (CAR):	25550 days		

INHALATION: ADULT EXPOSURE

IR:	14 m3/day	d:	1 mm	
BW:	70 Kg	ts:	2 sec	
Ds:	15 min	T1:	293 K	
Dt:	20 min	Ts:	318 K	
Ra:	0.0083 1/min	M1:	0.982 centipoise	
SV:	12 m3	M2:	0.616 centipoise	
ED:	30 yr	T:	293 K	
R:	0.000082 atm–m3/mol–K	FR:	10 L/min	
EF:	350 days/yr	AT:	10950 (NONCAR)	25550 (CARCIN)

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE TWO)
NAWC WARMINSTER
AREA C – Future resident adult
CALCULATE DOSES:

CHEMICAL	GW CONC. (MG/L)	MOLECULAR WEIGHT	HENRYS LAW CONSTANT	MASS TRANSFER COEFFICIENT (KA)	DERMAL PERM. CONSTANT	AIR CONCENTRATION (MG-MIN/L/SHOWER)
Tetrachloroethene	0.005	165.83	2.69E-02	1.34E+01	4.80E-02	2.66E-04
Antimony	0.019	121.75		0.00E+00	1.00E-03	0.00E+00
Arsenic	0.0041	74.92		0.00E+00	1.00E-03	0.00E+00
Barium	0.329	137.34		0.00E+00	1.00E-03	0.00E+00
Beryllium	0.00066	9.01		0.00E+00	1.00E-03	0.00E+00
Cadmium	0.0024	112.4		0.00E+00	1.00E-03	0.00E+00
Chromium	0.0066	51.99		0.00E+00	1.00E-03	0.00E+00
Cobalt	0.0037	58.93		0.00E+00	1.00E-03	0.00E+00
Copper	0.0157	63.54		0.00E+00	1.00E-03	0.00E+00
Manganese	1.6	54.94		0.00E+00	1.00E-03	0.00E+00
Thallium	0.0022	204.37		0.00E+00	1.00E-03	0.00E+00
Vanadium	0.0056	50.94		0.00E+00	1.00E-03	0.00E+00
Zinc	0.225	65.38		0.00E+00	1.00E-03	0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE THREE)
NAWC WARMINSTER
AREA C – Future resident adult
CALCULATE HAZARD INDICES:

CHEMICAL	ANNUAL INGESTION DOSE	ANNUAL DERMAL DOSE	ANNUAL INHALATION DOSE	INGESTION RfD	DERMAL RfD (GI ABS %age)	INHALATION RfD	HAZARD INDEX INGESTION	HAZARD INDEX DERMAL	HAZARD INDEX INHALATION	TOTAL HAZARD INDEX
Tetrachloroethene	1.37E-04	0.00E+00	5.10E-05	1.00E-02	1.00E-02 (100%)		1.37E-02	0.00E+00	0.00E+00	1.37E-02
Antimony	5.21E-04	0.00E+00	0.00E+00	4.00E-04	8.00E-03 (5%)		1.30E+00	0.00E+00	0.00E+00	1.30E+00
Arsenic	1.12E-04	0.00E+00	0.00E+00	3.00E-04	3.16E-04 (95%)		3.74E-01	0.00E+00	0.00E+00	3.74E-01
Barium	9.01E-03	0.00E+00	0.00E+00	7.00E-02	1.75E+00 (4%)	1.00E-04	1.29E-01	0.00E+00	0.00E+00	1.29E-01
Beryllium	1.81E-05	0.00E+00	0.00E+00	5.00E-03	2.50E-01 (2%)		3.62E-03	0.00E+00	0.00E+00	3.62E-03
Cadmium	6.58E-05	0.00E+00	0.00E+00	5.00E-04	2.50E-02 (2%)		1.32E-01	0.00E+00	0.00E+00	1.32E-01
Chromium	1.81E-04	0.00E+00	0.00E+00	5.00E-03 (hex)	2.50E-01 (2%)		3.62E-02	0.00E+00	0.00E+00	3.62E-02
Cobalt	1.01E-04	0.00E+00	0.00E+00	8.00E-03	1.33E-02 (60%)		1.27E-02	0.00E+00	0.00E+00	1.27E-02
Copper	4.30E-04	0.00E+00	0.00E+00	4.00E-02	8.00E-02 (50%)		1.08E-02	0.00E+00	0.00E+00	1.08E-02
Manganese	4.38E-02	0.00E+00	0.00E+00	5.00E-03	4.67E+00 (3%)	1.00E-05	8.77E+00	0.00E+00	0.00E+00	8.77E+00
Thallium	6.03E-05	0.00E+00	0.00E+00	8.00E-05	1.60E-03 (5%)		7.53E-01	0.00E+00	0.00E+00	7.53E-01
Vanadium	1.53E-04	0.00E+00	0.00E+00	7.00E-03	7.00E-01 (1%)		2.19E-02	0.00E+00	0.00E+00	2.19E-02
Zinc	6.16E-03	0.00E+00	0.00E+00	3.00E-01	1.20E+00 (25%)		2.05E-02	0.00E+00	0.00E+00	2.05E-02
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL HAZARD INDEX							1.16E+01	0.00E+00	0.00E+00	1.16E+01

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE FOUR)
NAWC WARMINSTER
AREA C – Future resident adult
CALCULATE INCREMENTAL CANCER RISK:

CHEMICAL	LIFETIME AVG INGESTION DOSE	LIFETIME AVG DERMAL DOSE	LIFETIME AVG INHALATION DOSE	CSF INGESTION	CSF DERMAL	CSF INHALATION	CANCER RISK INGESTION	CANCER RISK DERMAL	CANCER RISK INHALATION	TOTAL CANCER RISK
Tetrachloroethene	5.87E-05	0.00E+00	2.19E-05	5.20E-02	5.20E-02	2.00E-03	3.05E-06	0.00E+00	4.38E-08	3.10E-06
Antimony	2.23E-04	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	4.81E-05	0.00E+00	0.00E+00	1.80E+00	1.71E+00	1.50E+01	8.67E-05	0.00E+00	0.00E+00	8.67E-05
Barium	3.86E-03	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium	7.75E-06	0.00E+00	0.00E+00	4.30E+00	8.60E-02	8.40E+00	3.33E-05	0.00E+00	0.00E+00	3.33E-05
Cadmium	2.82E-05	0.00E+00	0.00E+00	B1		6.30E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium	7.75E-05	0.00E+00	0.00E+00	A		4.20E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	4.34E-05	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	1.84E-04	0.00E+00	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese	1.88E-02	0.00E+00	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium	2.58E-05	0.00E+00	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium	6.58E-05	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc	2.64E-03	0.00E+00	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL RISK							1.23E-04	0.00E+00	4.38E-08	1.23E-04

RISK ASSESSMENT SPREADSHEET – EXPOSURES THROUGH HOUSEHOLD USE OF GROUNDWATER

SITE NAME: NAWC WARMINSTER
LOCATION: AREA C – Future resident child
DATE: 07/28/94

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS. THREE EXPOSURE ROUTES ARE CONSIDERED: INGESTION OF GROUNDWATER, INHALATION OF VOLATILES DURING SHOWERING/BATHING, AND DERMAL CONTACT WHILE SHOWERING/BATHING. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO:

REFERENCES: EPA, DECEMBER 1989
FOSTER AND CHROSTOWSKI, 1987

INGESTION: IEX = (C x IR x EF x ED)/(BW x AT)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
IR = INGESTION RATE (LITERS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

DERMAL CONTACT: DEX = (C x PC x AV x ET x EF x ED)/(BW x AT x 1000)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
PC = THE PERMEABILITY CONSTANT OF CHEMICAL (CM/HR)
AV = THE SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
ET = EXPOSURE TIME (HRS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

INHALATION: IEX = (S x IR x EF x ED)/(BW x AT x Ra x 1E3)x(Ds + EXP(–Ra x Dt)/Ra – EXP(Ra x (Ds–Dt))/Ra)

WHERE:
S = VOLATILE ORGANIC CHEMICAL GENERATION RATE (UG/CUBIC METER/MIN)
IR = INHALATION RATE (LITERS/MIN)
Ds = SHOWER DURATION (MIN)
Ra = AIR EXCHANGE RATE (1/MIN)
Dt = TOTAL DURATION IN SHOWER ROOM (MIN)
BW = BODY WEIGHT (KG)
SV = SHOWER ROOM AIR VOLUME (m**3)
R = IDEAL GAS LAW CONSTANT (ATM–M**3/MOL/K)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
AT = AVERAGING TIME (DAYS)

INPUT PARAMETERS:

INGESTION: CHILD EXPOSURE

IR:	1 L/day	CONVERSION	
EF:	350 days/yr	FACTOR (NONCAR) =	6.39E–02
ED:	6 yr		
BW:	15 Kg	CONVERSION	
AT(NON):	2190 days	FACTOR (CARCIN) =	5.48E–03
AT(CAR):	25550 days		

DERMAL CONTACT: CHILD EXPOSURE

AV:	7280 cm2	CONVERSION	
ET:	0.25 hr	FACTOR (NONCAR) =	1.16E–01
EF:	350 days/yr		
ED:	6 yr	CONVERSION	
BW:	15 Kg	FACTOR (CARCIN) =	9.97E–03
AT (NON):	2190 days		
AT (CAR):	25550 days		

INHALATION: CHILD EXPOSURE

IR:	0 m3/day	d:	1 mm	
BW:	70 Kg	ts:	2 sec	
Ds:	15 min	T1:	293 K	
Dt:	20 min	Ts:	318 K	
Ra:	0.0083 1/min	M1:	0.982 centipoise	
SV:	12 m3	M2:	0.616 centipoise	
ED:	30 yr	T:	293 K	
R:	0.000082 atm–m3/mol–K	FR:	10 L/min	
EF:	350 days/yr	AT:	10950 (NONCAR)	25550 (CARCIN)

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE TWO)
NAWC WARMINSTER
AREA C – Future resident child
CALCULATE DOSES:

CHEMICAL	GW CONC. (MG/L)	MOLECULAR WEIGHT	HENRYS LAW CONSTANT	MASS TRANSFER COEFFICIENT (KA)	DERMAL PERM. CONSTANT	AIR CONCENTRATION (MG-MIN/L/SHOWER)
Tetrachloroethene	0.005	165.83	2.69E-02	1.34E+01	4.80E-02	2.66E-04
Antimony	0.019	121.75		0.00E+00	1.00E-03	0.00E+00
Arsenic	0.0041	74.92		0.00E+00	1.00E-03	0.00E+00
Barium	0.329	137.34		0.00E+00	1.00E-03	0.00E+00
Beryllium	0.00066	9.01		0.00E+00	1.00E-03	0.00E+00
Cadmium	0.0024	112.4		0.00E+00	1.00E-03	0.00E+00
Chromium	0.0068	51.99		0.00E+00	1.00E-03	0.00E+00
Cobalt	0.0037	58.93		0.00E+00	1.00E-03	0.00E+00
Copper	0.0157	63.54		0.00E+00	1.00E-03	0.00E+00
Manganese	1.6	54.94		0.00E+00	1.00E-03	0.00E+00
Thallium	0.0022	204.37		0.00E+00	1.00E-03	0.00E+00
Vanadium	0.0056	50.94		0.00E+00	1.00E-03	0.00E+00
Zinc	0.225	65.38		0.00E+00	1.00E-03	0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
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				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00

RISK ASSESSMENT SPREADSHEET - HOUSEHOLD USE OF GROUNDWATER (PAGE THREE)
NAWC WARMINSTER
AREA C - Future resident child
CALCULATE HAZARD INDICES:

CHEMICAL	ANNUAL INGESTION DOSE	ANNUAL DERMAL DOSE	ANNUAL INHALATION DOSE	INGESTION RfD	DERMAL RfD (GI ABS %age)	INHALATION RfD	HAZARD INDEX INGESTION	HAZARD INDEX DERMAL	HAZARD INDEX INHALATION	TOTAL HAZARD INDEX
Tetrachloroethene	3.20E-04	2.79E-05	0.00E+00	1.00E-02	1.00E-02 (100%)		3.20E-02	2.79E-03	0.00E+00	3.48E-02
Antimony	1.21E-03	2.21E-06	0.00E+00	4.00E-04	8.00E-03 (5%)		3.04E+00	2.76E-04	0.00E+00	3.04E+00
Arsenic	2.62E-04	4.77E-07	0.00E+00	3.00E-04	3.16E-04 (95%)		8.74E-01	1.51E-03	0.00E+00	8.75E-01
Barium	2.10E-02	3.83E-05	0.00E+00	7.00E-02	1.75E+00 (4%)	1.00E-04	3.00E-01	2.19E-05	0.00E+00	3.00E-01
Beryllium	4.22E-05	7.68E-08	0.00E+00	5.00E-03	2.50E-01 (2%)		8.44E-03	3.07E-07	0.00E+00	8.44E-03
Cadmium	1.53E-04	2.79E-07	0.00E+00	5.00E-04	2.50E-02 (2%)		3.07E-01	1.12E-05	0.00E+00	3.07E-01
Chromium	4.22E-04	7.68E-07	0.00E+00	5.00E-03 (hex)	2.50E-01 (2%)		8.44E-02	3.07E-06	0.00E+00	8.44E-02
Cobalt	2.37E-04	4.30E-07	0.00E+00	8.00E-03	1.33E-02 (60%)		2.96E-02	3.23E-05	0.00E+00	2.96E-02
Copper	1.00E-03	1.83E-06	0.00E+00	4.00E-02	8.00E-02 (50%)		2.51E-02	2.28E-05	0.00E+00	2.51E-02
Manganese	1.02E-01	1.86E-04	0.00E+00	5.00E-03	4.67E+00 (3%)	1.00E-05	2.05E+01	3.99E-05	0.00E+00	2.05E+01
Thallium	1.41E-04	2.56E-07	0.00E+00	8.00E-05	1.60E-03 (5%)		1.76E+00	1.60E-04	0.00E+00	1.76E+00
Vanadium	3.58E-04	6.52E-07	0.00E+00	7.00E-03	7.00E-01 (1%)		5.11E-02	9.31E-07	0.00E+00	5.11E-02
Zinc	1.44E-02	2.62E-05	0.00E+00	3.00E-01	1.20E+00 (25%)		4.79E-02	2.18E-05	0.00E+00	4.80E-02
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL HAZARD INDEX							2.70E+01	4.89E-03	0.00E+00	2.70E+01

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE FOUR)
NAWC WARMINSTER
AREA C – Future resident child
CALCULATE INCREMENTAL CANCER RISK:

CHEMICAL	LIFETIME AVG INGESTION DOSE	LIFETIME AVG DERMAL DOSE	LIFETIME AVG INHALATION DOSE	CSF INGESTION	CSF DERMAL	CSF INHALATION	CANCER RISK INGESTION	CANCER RISK DERMAL	CANCER RISK INHALATION	TOTAL CANCER RISK
Tetrachloroethene	2.74E-05	2.39E-06	0.00E+00	5.20E-02	5.20E-02	2.00E-03	1.42E-06	1.24E-07	0.00E+00	1.55E-06
Antimony	1.04E-04	1.69E-07	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	2.25E-05	4.09E-08	0.00E+00	1.80E+00	1.71E+00	1.50E+01	4.04E-05	6.99E-08	0.00E+00	4.05E-05
Barium	1.80E-03	3.28E-06	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium	3.62E-06	6.58E-09	0.00E+00	4.30E+00	8.60E-02	8.40E+00	1.56E-05	5.66E-10	0.00E+00	1.56E-05
Cadmium	1.32E-05	2.39E-08	0.00E+00	B1		6.30E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium	3.62E-05	6.58E-08	0.00E+00	A		4.20E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	2.03E-05	3.69E-08	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	8.60E-05	1.57E-07	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese	8.77E-03	1.60E-05	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium	1.21E-05	2.19E-08	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium	3.07E-05	5.58E-08	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc	1.23E-03	2.24E-06	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL RISK							5.74E-05	1.95E-07	0.00E+00	5.76E-05

RISK ASSESSMENT SPREADSHEET - EXPOSURES THROUGH HOUSEHOLD USE OF GROUNDWATER

SITE NAME: NAWC WARMINSTER
LOCATION: Site 4 Downgradient Wells - Adult residential exposure
DATE: 07/28/94

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS. THREE EXPOSURE ROUTES ARE CONSIDERED: INGESTION OF GROUNDWATER, INHALATION OF VOLATILES DURING SHOWERING/BATHING, AND DERMAL CONTACT WHILE SHOWERING/BATHING. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO:

REFERENCES: EPA, DECEMBER 1989
FOSTER AND CHROSTOWSKI, 1987

INGESTION: IEX = (C x IR x EF x ED)/(BW x AT)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
IR = INGESTION RATE (LITERS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

DERMAL CONTACT: DEX = (C x PC x AV x ET x EF x ED)/(BW x AT x 1000)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
PC = THE PERMEABILITY CONSTANT OF CHEMICAL (CM/HR)
AV = THE SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
ET = EXPOSURE TIME (HRS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

INHALATION: IEX = (S x IR x EF x ED)/(BW x AT x Ra x 1E3)x(Ds + EXP(-Ra x Dt)/Ra - EXP(Ra x (Ds-Dt))/Ra)

WHERE:
S = VOLATILE ORGANIC CHEMICAL GENERATION RATE (UG/CUBIC METER/MIN)
IR = INHALATION RATE (LITERS/MIN)
Ds = SHOWER DURATION (MIN)
Ra = AIR EXCHANGE RATE (1/MIN)
Dt = TOTAL DURATION IN SHOWER ROOM (MIN)
BW = BODY WEIGHT (KG)
SV = SHOWER ROOM AIR VOLUME (m**3)
R = IDEAL GAS LAW CONSTANT (ATM-M**3/MOL/K)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
AT = AVERAGING TIME (DAYS)

INPUT PARAMETERS:

INGESTION: ADULT EXPOSURE

IR:	2 L/day	CONVERSION	
EF:	350 days/yr	FACTOR (NONCAR) =	2.74E-02
ED:	30 yr		
BW:	70 Kg	CONVERSION	
AT(NON):	10950 days	FACTOR (CARCIN) =	1.17E-02
AT(CAR):	25550 days		

DERMAL CONTACT: ADULT EXPOSURE

AV:	19400 cm2	CONVERSION	
ET:	0 hr	FACTOR (NONCAR) =	0.00E+00
EF:	350 days/yr		
ED:	30 yr	CONVERSION	
BW:	70 Kg	FACTOR (CARCIN) =	0.00E+00
AT (NON):	10950 days		
AT (CAR):	25550 days		

INHALATION: ADULT EXPOSURE

IR:	14 m3/day	d:	1 mm	
BW:	70 Kg	ts:	2 sec	
Ds:	15 min	T1:	293 K	
Dt:	20 min	Ts:	318 K	
Ra:	0.0083 1/min	M1:	0.982 centipoise	
SV:	12 m3	M2:	0.616 centipoise	
ED:	30 yr	T:	293 K	
R:	0.000082 atm-m3/mol-K	FR:	10 L/min	
EF:	350 days/yr	AT:	10950 (NONCAR)	25550 (CARCIN)

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE TWO)
NAWC WARMINSTER
Site 4 Downgradient Wells – Adult residential exposure
CALCULATE DOSES:

CHEMICAL	GW CONC. (MG/L)	MOLECULAR WEIGHT	HENRYS LAW CONSTANT	MASS TRANSFER COEFFICIENT (KA)	DERMAL PERM. CONSTANT	AIR CONCENTRATION (MG-MIN/L/SHOWER)
Antimony	0.0209	121.75		0.00E+00	1.00E-03	0.00E+00
Arsenic	0.0041	74.92		0.00E+00	1.00E-03	0.00E+00
Barium	0.458	137.34		0.00E+00	1.00E-03	0.00E+00
Cadmium	0.0025	112.4		0.00E+00	1.00E-03	0.00E+00
Chromium	0.007	51.99		0.00E+00	1.00E-03	0.00E+00
Copper	0.0287	63.54		0.00E+00	1.00E-03	0.00E+00
Manganese	1.84	54.94		0.00E+00	1.00E-03	0.00E+00
Thallium	0.0024	204.37		0.00E+00	1.00E-03	0.00E+00
Vanadium	0.0109	50.94		0.00E+00	1.00E-03	0.00E+00
Zinc	0.225	65.38		0.00E+00	1.00E-03	0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE THREE)
NAWC WARMINSTER
Site 4 Downgradient Wells – Adult residential exposure
CALCULATE HAZARD INDICES:

CHEMICAL	ANNUAL INGESTION DOSE	ANNUAL DERMAL DOSE	ANNUAL INHALATION DOSE	INGESTION RfD	DERMAL RfD (GI ABS %age)	INHALATION RfD	HAZARD INDEX INGESTION	HAZARD INDEX DERMAL	HAZARD INDEX INHALATION	TOTAL HAZARD INDEX
Antimony	5.73E-04	0.00E+00	0.00E+00	4.00E-04	8.00E-03 (5%)		1.43E+00	0.00E+00	0.00E+00	1.43E+00
Arsenic	1.12E-04	0.00E+00	0.00E+00	3.00E-04	3.16E-04 (95%)		3.74E-01	0.00E+00	0.00E+00	3.74E-01
Barium	1.25E-02	0.00E+00	0.00E+00	7.00E-02	1.75E+00 (4%)	1.00E-04	1.79E-01	0.00E+00	0.00E+00	1.79E-01
Cadmium	6.85E-05	0.00E+00	0.00E+00	5.00E-04	2.50E-02 (2%)		1.37E-01	0.00E+00	0.00E+00	1.37E-01
Chromium	1.92E-04	0.00E+00	0.00E+00	5.00E-03 (hex)	2.50E-01 (2%)		3.84E-02	0.00E+00	0.00E+00	3.84E-02
Copper	7.86E-04	0.00E+00	0.00E+00	4.00E-02	8.00E-02 (50%)		1.97E-02	0.00E+00	0.00E+00	1.97E-02
Manganese	5.04E-02	0.00E+00	0.00E+00	5.00E-03	4.67E+00 (3%)	1.00E-05	1.01E+01	0.00E+00	0.00E+00	1.01E+01
Thallium	6.58E-05	0.00E+00	0.00E+00	8.00E-05	1.60E-03 (5%)		8.22E-01	0.00E+00	0.00E+00	8.22E-01
Vanadium	2.99E-04	0.00E+00	0.00E+00	7.00E-03	7.00E-01 (1%)		4.27E-02	0.00E+00	0.00E+00	4.27E-02
Zinc	6.16E-03	0.00E+00	0.00E+00	3.00E-01	1.20E+00 (25%)		2.05E-02	0.00E+00	0.00E+00	2.05E-02
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL HAZARD INDEX							1.31E+01	0.00E+00	0.00E+00	1.31E+01

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE FOUR)
NAWC WARMINSTER
Site 4 Downgradient Wells – Adult residential exposure
CALCULATE INCREMENTAL CANCER RISK:

CHEMICAL	LIFETIME AVG INGESTION DOSE	LIFETIME AVG DERMAL DOSE	LIFETIME AVG INHALATION DOSE	CSF INGESTION	CSF DERMAL	CSF INHALATION	CANCER RISK INGESTION	CANCER RISK DERMAL	CANCER RISK INHALATION	TOTAL CANCER RISK
Antimony	2.45E-04	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	4.81E-05	0.00E+00	0.00E+00	1.80E+00	1.71E+00	1.50E+01	8.67E-05	0.00E+00	0.00E+00	8.67E-05
Barium	5.38E-03	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	2.94E-05	0.00E+00	0.00E+00	B1		6.30E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium	8.22E-05	0.00E+00	0.00E+00	A		4.20E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	3.37E-04	0.00E+00	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese	2.16E-02	0.00E+00	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium	2.82E-05	0.00E+00	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium	1.28E-04	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc	2.64E-03	0.00E+00	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL RISK							8.67E-05	0.00E+00	0.00E+00	8.67E-05

RISK ASSESSMENT SPREADSHEET – EXPOSURES THROUGH HOUSEHOLD USE OF GROUNDWATER

SITE NAME: NAWC WARMINSTER
LOCATION: Site 4 Downgradient Wells – Child residential exposure
DATE: 07/28/94

HAZARD INDICES AND INCREMENTAL CANCER RISKS ARE CALCULATED BY ON THE FOLLOWING SPREADSHEETS. THREE EXPOSURE ROUTES ARE CONSIDERED: INGESTION OF GROUNDWATER, INHALATION OF VOLATILES DURING SHOWERING/BATHING, AND DERMAL CONTACT WHILE SHOWERING/BATHING. ASSUMPTIONS ARE OUTLINED BELOW.

EXPOSURE SCENARIO:

REFERENCES: EPA, DECEMBER 1989
FOSTER AND CHROSTOWSKI, 1987

INGESTION: IEX = (C x IR x EF x ED)/(BW x AT)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
IR = INGESTION RATE (LITERS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

DERMAL CONTACT: DEX = (C x PC x AV x ET x EF x ED)/(BW x AT x 1000)

WHERE:
C = GROUNDWATER CONCENTRATION (MG/L)
PC = THE PERMEABILITY CONSTANT OF CHEMICAL (CM/HR)
AV = THE SKIN SURFACE AREA AVAILABLE FOR CONTACT (CM**2)
ET = EXPOSURE TIME (HRS/DAY)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
BW = BODY WEIGHT (KG)
AT = AVERAGING TIME (DAYS)

INHALATION: IEX = (S x IR x EF x ED)/(BW x AT x Ra x 1E3)x(Ds + EXP(–Ra x Dt)/Ra – EXP(Ra x (Ds–Dt))/Ra)

WHERE:
S = VOLATILE ORGANIC CHEMICAL GENERATION RATE (UG/CUBIC METER/MIN)
IR = INHALATION RATE (LITERS/MIN)
Ds = SHOWER DURATION (MIN)
Ra = AIR EXCHANGE RATE (1/MIN)
Dt = TOTAL DURATION IN SHOWER ROOM (MIN)
BW = BODY WEIGHT (KG)
SV = SHOWER ROOM AIR VOLUME (m**3)
R = IDEAL GAS LAW CONSTANT (ATM–M**3/MOL/K)
EF = EXPOSURE FREQUENCY (DAYS/YEAR)
ED = EXPOSURE DURATION (YEARS)
AT = AVERAGING TIME (DAYS)

INPUT PARAMETERS:

INGESTION: CHILD EXPOSURE

IR:	1 L/day	CONVERSION	
EF:	350 days/yr	FACTOR (NONCAR) =	6.39E–02
ED:	6 yr		
BW:	15 Kg	CONVERSION	
AT(NON):	2190 days	FACTOR (CARCIN) =	5.48E–03
AT(CAR):	25550 days		

DERMAL CONTACT: CHILD EXPOSURE

AV:	7280 cm2	CONVERSION	
ET:	0.25 hr	FACTOR (NONCAR) =	1.16E–01
EF:	350 days/yr		
ED:	6 yr	CONVERSION	
BW:	15 Kg	FACTOR (CARCIN) =	9.97E–03
AT (NON):	2190 days		
AT (CAR):	25550 days		

INHALATION: CHILD EXPOSURE

IR:	0 m3/day	d:	1 mm	
BW:	70 Kg	ts:	2 sec	
Ds:	15 min	T1:	293 K	
Dt:	20 min	Ts:	318 K	
Ra:	0.0083 1/min	M1:	0.982 centpoise	
SV:	12 m3	M2:	0.616 centpoise	
ED:	30 yr	T:	293 K	
R:	0.000082 atm–m3/mol–K	FR:	10 L/min	
EF:	350 days/yr	AT:	10950 (NONCAR)	25550 (CARCIN)

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE TWO)
NAWC WARMINSTER
Site 4 Downgradient Wells – Child residential exposure
CALCULATE DOSES:

CHEMICAL	GW CONC. (MG/L)	MOLECULAR WEIGHT	HENRYS LAW CONSTANT	MASS TRANSFER COEFFICIENT (KA)	DERMAL PERM. CONSTANT	AIR CONCENTRATION (MG-MIN/L/SHOWER)
Antimony	0.0209	121.75		0.00E+00	1.00E-03	0.00E+00
Arsenic	0.0041	74.92		0.00E+00	1.00E-03	0.00E+00
Barium	0.458	137.34		0.00E+00	1.00E-03	0.00E+00
Cadmium	0.0025	112.4		0.00E+00	1.00E-03	0.00E+00
Chromium	0.007	51.99		0.00E+00	1.00E-03	0.00E+00
Copper	0.0287	63.54		0.00E+00	1.00E-03	0.00E+00
Manganese	1.84	54.94		0.00E+00	1.00E-03	0.00E+00
Thallium	0.0024	204.37		0.00E+00	1.00E-03	0.00E+00
Vanadium	0.0109	50.94		0.00E+00	1.00E-03	0.00E+00
Zinc	0.225	65.38		0.00E+00	1.00E-03	0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00
				0.00E+00		0.00E+00

RISK ASSESSMENT SPREADSHEET - HOUSEHOLD USE OF GROUNDWATER (PAGE THREE)
NAWC WARMINSTER
Site 4 Downgradient Wells - Child residential exposure
CALCULATE HAZARD INDICES:

CHEMICAL	ANNUAL INGESTION DOSE	ANNUAL DERMAL DOSE	ANNUAL INHALATION DOSE	INGESTION RfD	DERMAL RfD (GI ABS %age)	INHALATION RfD	HAZARD INDEX INGESTION	HAZARD INDEX DERMAL	HAZARD INDEX INHALATION	TOTAL HAZARD INDEX
Antimony	1.34E-03	2.43E-06	0.00E+00	4.00E-04	8.00E-03 (5%)		3.34E+00	3.04E-04	0.00E+00	3.34E+00
Arsenic	2.62E-04	4.77E-07	0.00E+00	3.00E-04	3.16E-04 (95%)		8.74E-01	1.51E-03	0.00E+00	8.75E-01
Barium	2.93E-02	5.33E-05	0.00E+00	7.00E-02	1.75E+00 (4%)	1.00E-04	4.18E-01	3.04E-05	0.00E+00	4.18E-01
Cadmium	1.60E-04	2.91E-07	0.00E+00	5.00E-04	2.50E-02 (2%)		3.20E-01	1.16E-05	0.00E+00	3.20E-01
Chromium	4.47E-04	8.14E-07	0.00E+00	5.00E-03 (hex)	2.50E-01 (2%)		8.95E-02	3.26E-06	0.00E+00	8.95E-02
Copper	1.83E-03	3.34E-06	0.00E+00	4.00E-02	8.00E-02 (50%)		4.59E-02	4.17E-05	0.00E+00	4.59E-02
Manganese	1.18E-01	2.14E-04	0.00E+00	5.00E-03	4.67E+00 (3%)	1.00E-05	2.35E+01	4.59E-05	0.00E+00	2.35E+01
Thallium	1.53E-04	2.79E-07	0.00E+00	8.00E-05	1.60E-03 (5%)		1.92E+00	1.75E-04	0.00E+00	1.92E+00
Vanadium	6.97E-04	1.27E-06	0.00E+00	7.00E-03	7.00E-01 (1%)		9.95E-02	1.81E-06	0.00E+00	9.95E-02
Zinc	1.44E-02	2.62E-05	0.00E+00	3.00E-01	1.20E+00 (25%)		4.79E-02	2.18E-05	0.00E+00	4.80E-02
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL HAZARD INDEX							3.07E+01	2.15E-03	0.00E+00	3.07E+01

RISK ASSESSMENT SPREADSHEET – HOUSEHOLD USE OF GROUNDWATER (PAGE FOUR)
NAWC WARMINSTER
Site 4 Downgradient Wells – Child residential exposure
CALCULATE INCREMENTAL CANCER RISK:

CHEMICAL	LIFETIME AVG INGESTION DOSE	LIFETIME AVG DERMAL DOSE	LIFETIME AVG INHALATION DOSE	CSF INGESTION	CSF DERMAL	CSF INHALATION	CANCER RISK INGESTION	CANCER RISK DERMAL	CANCER RISK INHALATION	TOTAL CANCER RISK
Antimony	1.15E-04	2.08E-07	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	2.25E-05	4.09E-08	0.00E+00	1.80E+00	1.71E+00	1.50E+01	4.04E-05	6.99E-08	0.00E+00	4.05E-05
Barium	2.51E-03	4.57E-06	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	1.37E-05	2.49E-08	0.00E+00	B1		6.30E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium	3.84E-05	6.98E-08	0.00E+00	A		4.20E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	1.57E-04	2.86E-07	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese	1.01E-02	1.83E-05	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium	1.32E-05	2.39E-08	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium	5.97E-05	1.09E-07	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc	1.23E-03	2.24E-06	0.00E+00	D			0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL RISK							4.04E-05	6.99E-08	0.00E+00	4.05E-05